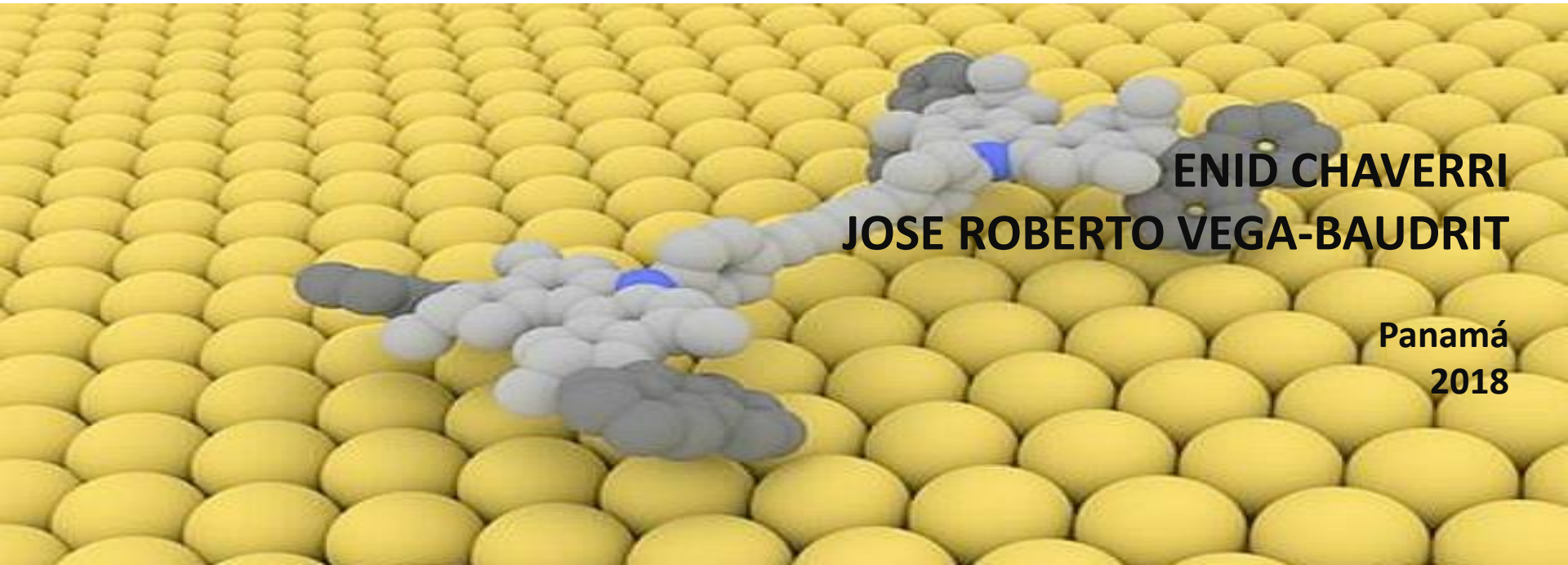
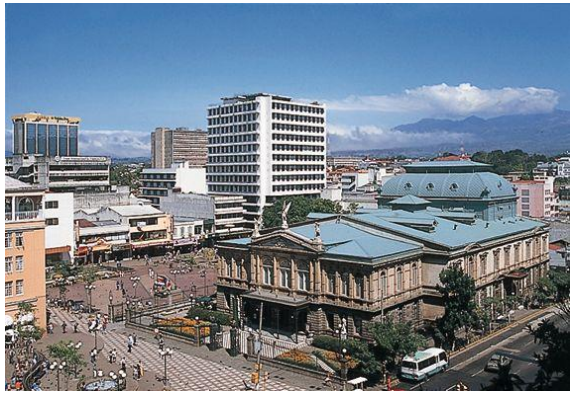
Nanotecnología sustentables en Costa Rica
LANOTEC CENAT



ENID CHAVERRI
JOSE ROBERTO VEGA-BAUDRIT

Panamá
2018



COSTA RICA 2017

Costa Rica

Capital	San José
Idioma oficial	Español
Superficie • Total	51.100 km^2
Población • Total • Densidad	4.900 000 (2016 est.) 89 hab/km^2
PIB (PPA) • Total • PIB per cápita	US$ 59.220 millones (2016 est.) US$ 12.000 (2016)
Moneda	Colón costarricense (aprox 575 ¢ POR 1$)
NO hay ejército	ALTO PRESPUESTO PARA EDUCACIÓN .

- En 2007 el Gobierno de Costa Rica anunció planes para convertirse en el **primer país del mundo neutral en carbono** para el año 2021, cuando cumplirá su bicentenario como nación independiente.

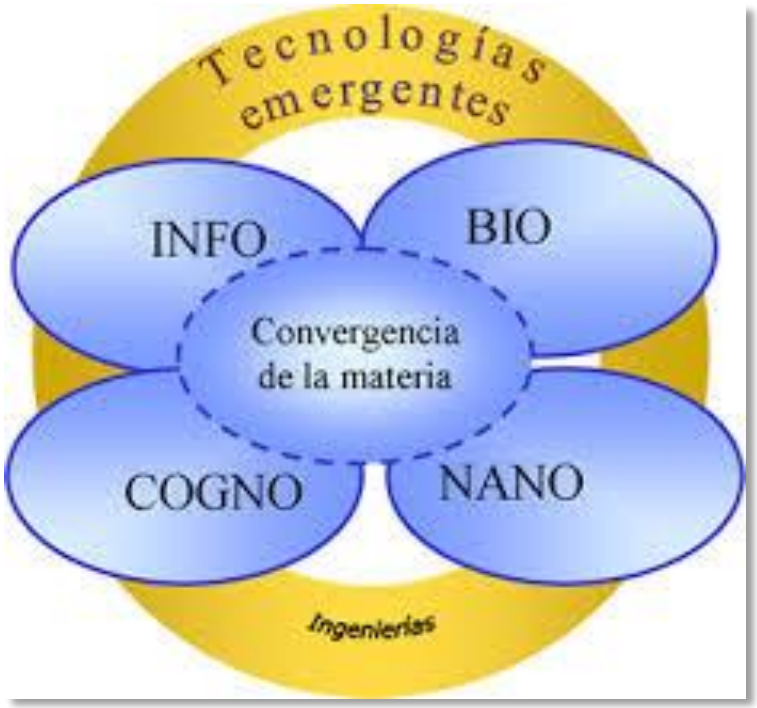
- Happy planet index: clasificó a Costa Rica como el "más verde“, ecológico, sustentable y feliz de los países del mundo en 2016.

- Economía basada en **ecoturismo, servicios, componentes electrónicos y médicos, y agroindustrialización.**

COSTA RICA: ambiente: principal riqueza BIODIVERSIDAD y cuido al medio ambiente…!!!

Nanotecnología
Ciencia y tecnologías transgresoras

- Tecnologías convergentes y emergentes.
- Fenómeno del siglo XXI.
- Nanotecnología y Biotecnología.
- PRODUCTO COMERCIAL..!!!



LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Impacto de la nanotecnología en la industria mundial:

- Alimentos
- Salud: dispositivos médicos y farmacia
- Polímeros
- Construcción
- Electrónica
- Cerámicas y vidrio
- Agroindustria y revalorización de subproductos
- Textiles
- Deportes
- Cosmética
- Agua, energía y ambiente

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Nanotecnología en CR: Hechos

1. Estrategia del Siglo XXI.
2. Decreto del MICITT, 2011.
3. Programas y redes universitarias.
4. Programa Nacional de Desarrollo, PNDN, 2013.
5. Incorporación a la Secretaría de Sustancias Químicas
   - *Comisión de Nanotecnología*: MS, MINAE, CONARE.
6. Creación del LANOTEC-CeNAT, 2004.

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Fortalezas en el desarrollo sostenible de la nanotecnología en Costa Rica

- Biodiversidad.
- Nanomedicina y nanofarmacia.
- Nanobiotecnología.
- Nano-microelectrónica.
- Nanotecnología y medio ambiente.
- Empleo de desechos agroindustriales y marinos para la obtención de nuevos materiales o su mejoramiento.
- Nano y microsensores.
- Biorefinería.
- Nanocompuestos.
- Nanocatalizadores.
- Energía y nuevas fuentes alternativas de energía.
- Vocaciones científicas y educación.
- Nanometrología.
- Nanoseguridad y nanoregulación.
- Aspectos éticos y sociales de la nanotecnología y su desarrollo en Costa Rica.

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Laboratorio Nacional de Nanotecnología: LANOTEC v3.0

Creación del Laboratorio Nacional de Nanotecnología

Administración del LANOTEC

Edificio CeNAT – CONARE

Dr. F. Chang Diaz

Antiguo AID, Donación gobierno.

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

LANOTEC

- Inauguración: agosto 2004.
- Inicia funciones: julio 2006.
- Superficie: 500 m^2.
- Inversión inicial: $50,000.
- Laboratorio de química y biología, cuarto instrumental, planta piloto (quitina, nanocelulosa), laboratorio para producir NTC, oficinas, biblioteca.

Fondos para investigación

1. CeNAT-CONARE.
2. Fondos concursables internacionales.
3. Fondos Educacion Estatal Superior FEES.
4. Fondos de Incentivos, Pymes MICITT-CONICIT.
5. Empresariales.

- Otros: CRUSA, AEA, Europeos, Redes, privados, proyectos vinculación externa.

Inversión de más de
$ 8 000 000,00 + el edificio +
gastos de mantenimiento

Objetivos

- **Investigar** en el área de la Micro y Nanotecnología enfocado en nanoestructuras, microsensores y materiales avanzados.
- Servir de **centro-laboratorio** para la formación en nanotecnología en colaboración con instituciones y programas académicos.
- Establecer **alianzas estratégicas** con industrias de alta tecnología para el desarrollo de servicios y productos especializados que contribuyan con el sector productivo del país.

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

- **Dr. José Vega Baudrit, Director**
- Dr. Orlando Arguello, Nanobiotecnología.
- Dra. Yendry Corrales, IQ, Química, AFM
- Dr. Bernal Sibaja, Químico, Materiales
- Dr. Daniel Chavarría, Odontólogo
- Dra. Vanessa Zamora Mora, Química, polímeros
- M.Sc. Melissa Camacho, Química, Innovación
- M.Sc. Carlos Redondo, Químico, síntesis.
- M.Sc. Audry Soncsich, Química, Biorefinería
- M.Sc. Gabriela Montes de Oca, Biotecnóloga.
- M.Sc. Marilyn Porras, Microbiología.
- M.Sc. Andrea Araya, Química
- Lic. Laura Bolaños, Bióloga.
- I.Q. Andrea Rivera, Ing. Química.
- B. Reinaldo Pereira , Biólogo, TEM, SEM.
- B.Q. Felipe Orozco, Químico
- Ing. Ricardo Alvarado, Biotecnólogo.
- Lic. Andrea Solano, Comunicadora
- Ing. Mec. Carlos Villalobos, mecatrónica

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

EQUIPO MULTIDISCIPLINARIO

- Lic. Galia Moreno, Química
- Lic. Gastón Baudrit, CONARE, Abogado.
- Flor Flores, Asistente administrativa.
- Lic. Cynthia Cordero, Administrador, FUNCENAT
- Tesiarios nacionales e internacionales, Becas CENAT.
- Estudiantes Proyecto Olimpiada Química: UCR, TEC, UNA, UNED, LANOTEC
- Estudiantes y profesores de TCU de la UCR, TEC, UNA
- Dr. Leo Lesser, Ing Eléctrico
- Dr. Víctor Hugo Soto Tellini, Químico
- Dr. Giovanni Sáenz, Físico
- Dr. José Saavedra, Físico
- Dr. Jorge Cubero, Ing. Mecánico
- M.Sc. Allan Campos, Físico.
- Ing. Santiago Nunez, Informático
- Dra. Jeanette Benavides, NASA

Apoyo

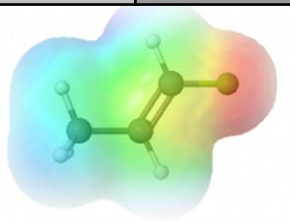
Áreas de trabajo en el LANOTEC

Producto

Socios: universidades y centros de investigación, gobierno, empresas

Investigación: 6 Nodos de desarrollo:

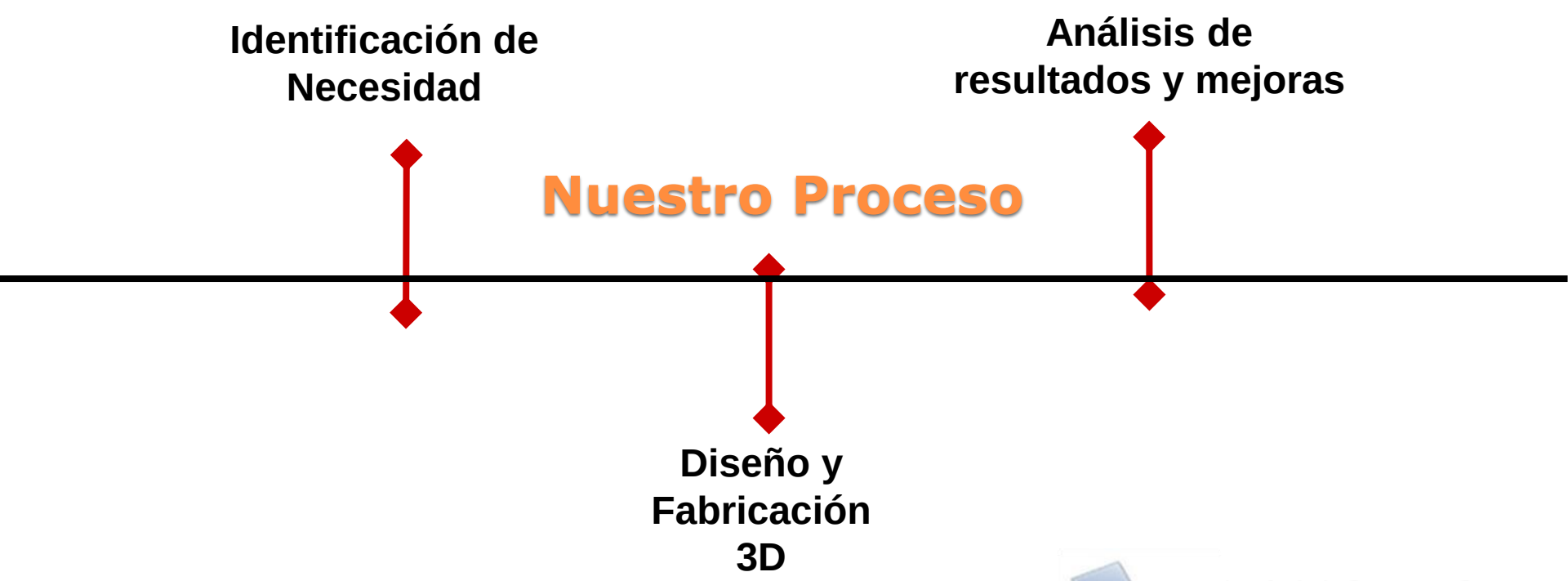
Nodo	Tipología	Temas	Objetivo
Nanobiotecnología	Área	Salud, nuevos materiales, PLA.	Procesos de Innovación
Energías renovables, sensores y metrología	Programa	Biomasa, algas, eólicas, superficies. Reactor de condiciones supercríticas. Patrones de referencia.	
Materiales avanzados	Área	Polímeros, materiales compuestos, nanocelulosa, quitina, lignina. NANOBIODIVERSIDAD NANOBIOMIMETISMO Biorefinería	
Ciencias básicas	Áreas	Química, física, biología	
TIC´s	Programa	Modelado, simulación, clúster, trabajo en red, internet 2.	
Salud-alimentos-nanobioseguridad	Programa	Terapias contra enfermedades, liberación controlada, principios activos y excipientes, vesículas lipídicas.	



PROYECTOS

1. Aplicaciones de Impresión 3D.

Carlos M. Villalobos Bermúdez



LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Pry01-1082-2017-Síntesis, caracterización y evaluación de la biocompatibilidad de un andamio de PLA fabricado por impresión 3D

1.1. Creación de Andamiajes.

Dr. Daniel Chavarría

UNIVERSIDAD DE COSTA RICA
OFICINA DE PLANIFICACIÓN UNIVERSITARIA
SISTEMA INSTITUCIONAL PLAN PRESUPUESTO

INFORMACION GENERAL DEL PROYECTO

Unidad:	01050300-FACULTAD DE ODONTOLOGIA	Proyecto:	Pry01-1082-2017-Síntesis, caracterización y evaluación de la biocompatibilidad de un andamio de PLA fabricado por impresión 3D
Código de Inscripción:		Estado:	Editable
Fecha de Inicio:	02/01/2017	Ampliación / Renovación:	
Fecha de Finalización:	31/12/2017	Usuario:	daniel.chavarria

Actividad / Subactividad

Investigación — Investigación Aplicada

Descripción:

El proyecto consiste en fabricar un andamio de PLA por medio del método de impresión 3D; realizar su caracterización mediante calorimetría diferencial de barrido (DSC), termogravimetría (TGA), evaluación morfológica mediante microscopía electrónica de barrido y perfilometría; y evaluación de su biocompatibilidad mediante pruebas de viabilidad celular (MTT) y adhesión celular.

Observaciones:

35

Fatigue limit of Y-TZP reinforced with carbon nanotubes

L.H. Silva[1], D.R.R. Lazar[2], V. Ussui[2], W.K. Yoshito[2], R.N. Tango[3], R. Belli[4], U. Lohbauer[4], P.F. Cesar[5,*]

[1] *University City of São Paulo/UNICID, Brazil*
[2] *Institute for Energetic and Nuclear Research/Ipen, Brazil*
[3] *University of the State of São Paulo/UNESP, Brazil*
[4] *Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany*
[5] *University of São Paulo, Brazil*

Purpose/aim: To compare the Cyclic Fatigue Limit (CFL) of a control yttria-stabilized tetragonal zirconia pollycristal (Y-TZP) with a composite produced by adding multi-walled carbon nanotubes (CNT) into Y-TZP.

Materials and methods: CNT were coated with zirconium oxide and yttrium oxide to form a powder (CNT/ZYO) using a hydrothermal co-precipitation method. Powders made of Y-TZP + (CNT/ZYO) were produced using 99 vol% of Y-TZP and 1 vol% of CNT/ZYO. CAD-CAM blocks (42.5 × 16.0 × 16.0 mm) were obtained by uniaxial pressing (67 MPa/30 s) of each powder in a steel matrix. These blocks were partially sintered at argon atmosphere (1100 °C/1 h/5 °C/s) and then sectioned to produce 14 bar-shaped specimens (3.0 × 4.0 × 25.0 mm/edges chamfered according to ISO6872:2008) of each material, which were sintered also in argon atmosphere (1.400 °C/4 h/5 °C/min). Density measured by Archimedes' method was used to calculate the relative density (RD), based on the theoretical values for both materials (6.06 g/cm^3). Flexural strength (FS) was measured in four-point bending with specimens immersed in water at 37 °C (inner and outer supports of 10 and 20 mm). CFL was determined in four-point bending, using the staircase method (10,000 cycles/5 Hz). In each cycle, the stress varied between the maximum stress (MS) and 50% of MS. The applied stress in the first specimen was 50% of FS. After 10,000 cycles, in case the specimen did not fracture, 10 MPa was added to the next specimen. RD and FS were analyzed by Student's *t* test (alpha = 5%). CFL was calculated according to: CLF = X0 + *d*(SUMini/SUMni ± 0.5), where X0 is the lowest stress value tested, *d* is the stress added or subtracted to each cycle and n is the number specimens that survived or failed in each stress level. The lowest stress level was computed as i = 0, and the next one was computed as i = 1, and so on. Fracture surfaces were fractographically analyzed.

Results: Specimens containing nanotubes showed significantly lower RD compared to the control ($p = 0.009$). Nanotube addition also caused a 50% significant decrease in FS ($p = 0.003$). However, the FS coefficient of variation for the control was higher (17%) compared to that of the composite (10%). CFL calculated for the control was 2.5 times higher than that of the composite. The %CFL (CFL in terms of percentage of the FS) was also higher for the control. Fractography indicated fracture origins associated to surface defects and porous regions related to nanotube agglomerates.

Conclusions: The processing method used to produce the composite Y-TZP/nanotubes needs to be improved since nanotube addition to Y-TZP caused a significant reduction of the relative density, strength and fatigue limit.

Material	Relative density (%)	Flexural strength (MPa)	CFL (MPa)	%CFL
Y-TZP (control)	98.6 ± 0.05^A	623.7 ± 108.8^A	439.0 ± 56.4	70%
Composite Y-TZP/ nanotubes	97.4 ± 0.03^B	299.4 ± 30.5^B	179.4 ± 22.5	60%

http://dx.doi.org/10.1016/j.dental.2017.08.036

36

Characterization and cellular response of 3D-scaffold functionalized with PLA nanofibers

F.C. Vazquez-Vazquez[1], D. Chavarria-Bolaños[2,*], D. Villalobos-Vega[2], J. Vega-Baudrit[3], A. Pozos-Guillén[4], D. Masuoka-Ito[5], M. Álvarez-Pérez[1]

[1] *Universidad Nacional Autónoma De México, Cdmx, Mexico*
[2] *Universidad De Costa Rica, San José, Costa Rica*
[3] *Centro Nacional De Alta Tecnología, Laboratorio Nacional De Nanotecnología, San José, Costa Rica*
[4] *Universidad Autónoma De San Luis Potosí, San Luis Potosí, Mexico*
[5] *Universidad Autónoma De Aguascalientes, Aguascalientes, Mexico*

Purpose/aim: Characterized the physicochemical properties, microtopography and cellular response of a 3D scaffold functionalized with PLA nanofibers.

Materials and methods: Cylindrical 3D scaffolds (5 mm diameter and 20 mm height) were designed and fabricated by PLA 3D printing. The scaffolds were then functionalized with 6% PLA nanofibers by airjet spinning. Samples of each scaffold were evaluated by thermogravimetric analysis (TGA) to determine onset point (To) inflection point and (Tp) mass loss temperature (Tmax). All specimens were then evaluated by differential scanning calorimetry (DSC) to determine glass transition temperature (Tg) and melting point (Tm). Tg was confirmed by dynamic mechanical analysis (DMA). Microtopography was evaluated by scanning electron microscopy (SEM) at 100×, 500×, 2000× and 5000×. Human osteoblasts (hOB) were selected to perform cellular adhesion assay and cellular proliferation evaluation by MTT assay. Data were analyzed and compared using two-way ANOVA test.

Results: To, Tp and Tmax were comparable between both scaffolds, as well as Tg and Tm. 3D scaffold showed homogeneous non-porous microtopography, with well adapted printing patterns. The PLA nanofibers layer was well adapted

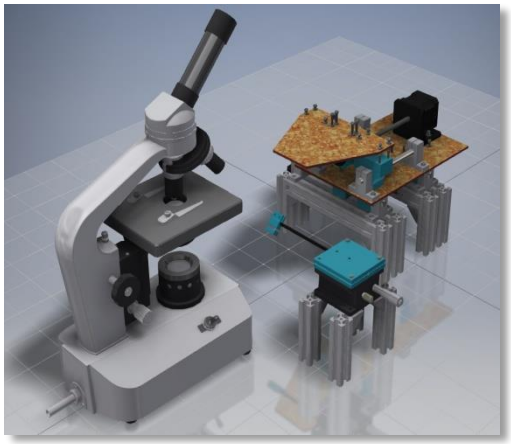
Caracterizar las propiedades fisicoquímicas , microtopografía y respuesta celular de scaffolds funcionalizadas con nanofibras de PLA

1.2. Creación de nuevos Equipos.

- **Micromanipulador de Células.**
- **5a. Patente**
- **Tesis de Lic. Universidad Dual Invenia**

Por medio de **Diseño e Impresión en 3D**, se se creó un Micromanipulador: para realizar análisis en una sola célula.

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA



2. Producción de biodiesel a partir de lípidos provenientes de microorganismos oleaginosos que utilizan residuos agrícolas orgánicos como sustrato, en un proceso de bajo costo energético.

M.Sc. Melissa Palma, M.Sc. Gabriela Montes de Oca

Objetivo del proyecto: Producción de biodiesel a partir de microorganismos oleaginosos.

Reactor en condiciones supercríticas, Proyecto PYME, MICITT

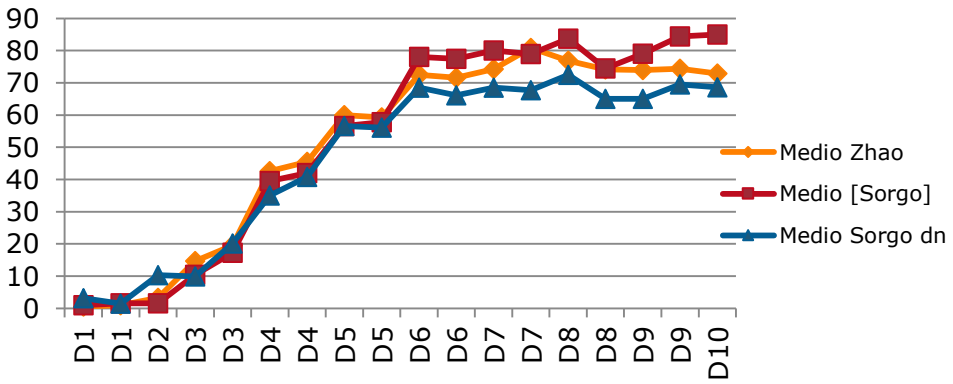


Fig. 1. Curvas de crecimiento de la levadura *L. starkeyi* en los tres medios de cultivo de prueba. (D=día).

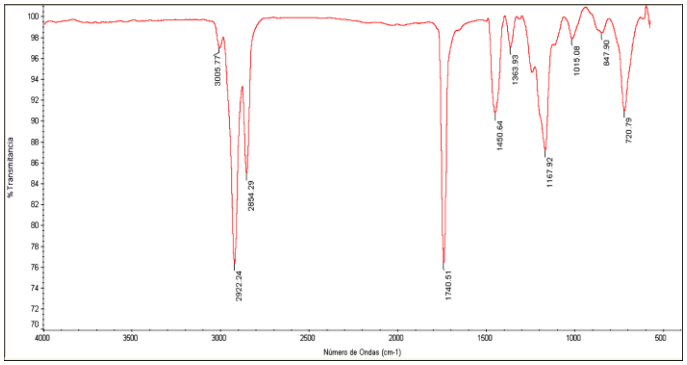


Fig. 3. Análisis Infrarrojo del biodiesel del aceite.

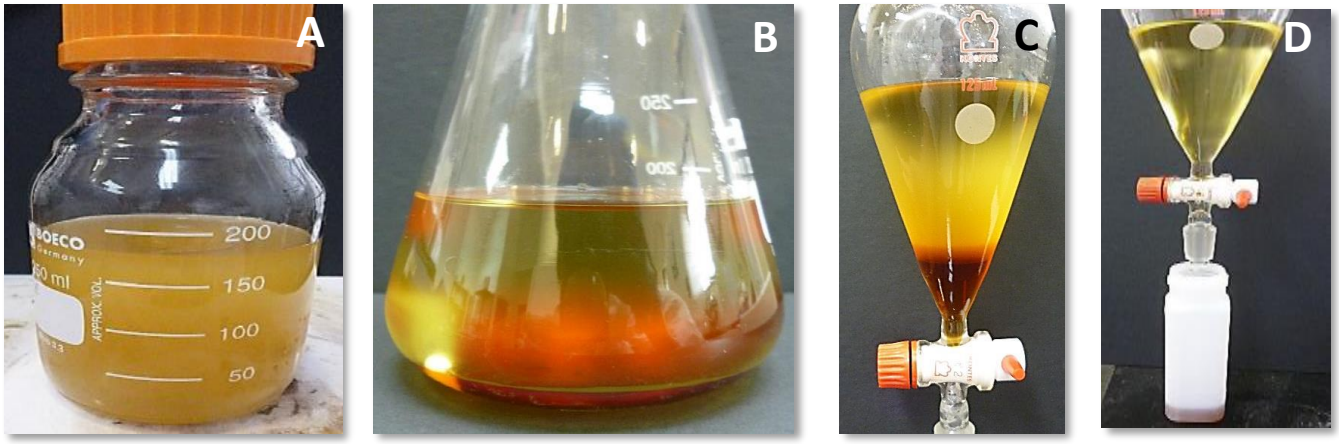


Fig. 2. De biodiesel obtenido: separación del glicerol y el aceite. **A.** Solución del biodiesel preparado a partir del aceite (Palma y corona por separado). **B.** Solución tratada con Metanol. **C.** Separación del glicerol y el biodiesel. **D.** Obtención del glicerol y biodiesel por separado.

Fig. 4. Crecimiento de la levadura conteniendo aceite.

3. Desarrollo participativo de alternativas para el tratamiento y aprovechamiento de residuos orgánicos en las comunidades de Rosaclaus y Macondo, distrito de Lepanto, Puntarenas.

M.Sc. Melissa Palma, Ing. Andrea Rivera

Objetivo del proyecto: Utilizar tecnologías no convencionales para el tratamiento de residuos orgánicos en las comunidades de Rosaclaus y Macondo, distrito de Lepanto, Puntarenas.

Fig. 1. Asesoramiento a la comunidad por medio de: talleres, charlas informativas, capacitaciones y asesoramiento de las tecnologías no convencionales y métodos alternativos de aprovechamiento de residuos orgánicos

Fig. 2. Construcción de una biojardinera en una casa, cuyo funcionamiento permite la reutilización de las aguas grises

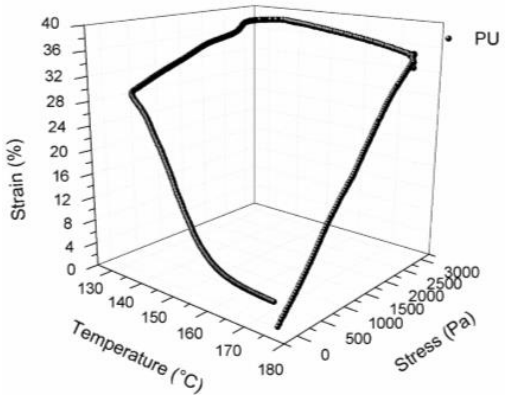
Fig. 3. Elaboración de compost como método de tratamiento de residuos orgánicos.

PROYECTO DE ACCION SOCIAL

4. Polímeros y Materiales Compuestos a partir de Fuentes Renovables

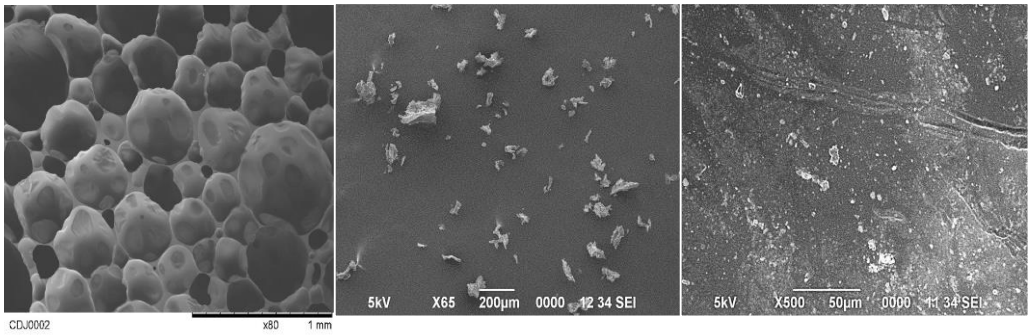
Dr. Rodolfo Jesús González-Paz

Materiales con Memoria de forma



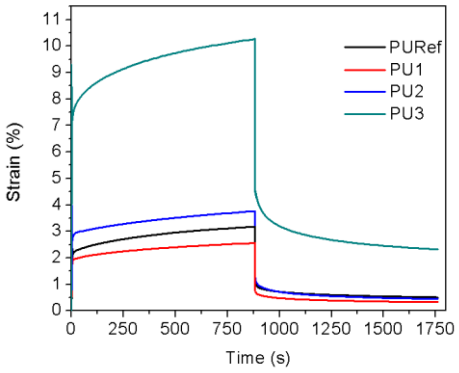
Refuerzo de Materiales con Micro y Nanoestructuras

Materiales Micro y Nanoestructurados (Imágenes SEM)



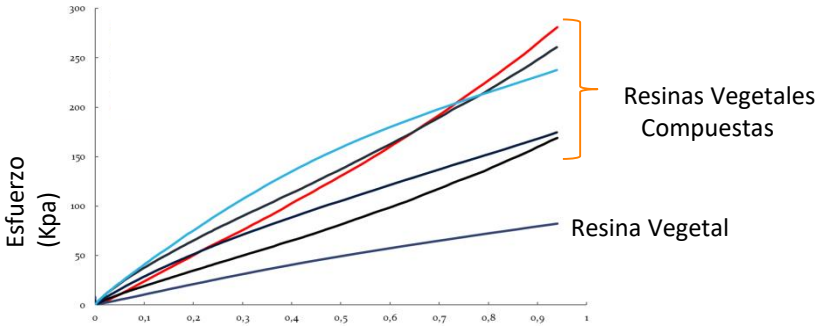
Bioespumas Vegetales | **Micro y Nanocelulosa** | **Resinas Vegetales Compuestas**

Materiales con Alto Desempeño



ENSAYO DE CREEP

ENSAYO DE TORSIÓN



La Nación, nov, 2016.

ALDEA GLOBAL

www.nacion.com
Ivannia Varela, editora de Aldea Global
ivannia.varela@nacion.com

→ Investigadores desarrollaron un poliuretano derivado de compuestos vegetales

Ciencia moldea tabla de surf de campeón centroamericano

- Surfista Óscar Urbina destaca la rapidez del material para recobrar forma
- Govan Project y Lanotec prevén que prototipo estará listo en abril del 2017

Michelle Soto M.
msoto@nacion.com

Esa mañana de este 13 de noviembre, Óscar Urbina se enfrentaría con una de las finales del Campeonato Centroamericano de Surf.

Se levantó a las 4 a. m. y, entre cuatro tablas a su disposición, decidió practicar con la verde.

"La primera ola que agarré con ella –¡cómo le digo!–, la tabla se fue sola. Era una tabla mágica", relató Urbina.

Aquel domingo, Urbina se coronó como campeón centroamericano de surf en la categoría Boys (Sub-16).

¿Qué hace tan especial esa tabla verde? La respuesta está en la ciencia y la tecnología detrás de su elaboración.

Investigadores de la empresa Govan Project, en alianza con el Laboratorio Nacional de Nanotecnología (Lanotec), del Centro Nacional de Alta Tecnología (Cenat), trabajan en un material llamado *biofoam*, el cual tiene memoria de forma.

"Para explicar qué es memoria de forma, imagínese una liga: uno la estira, la suelta, y esta recobra su forma original", explicó José Vega, del Lanotec.

En el caso del *biofoam*, el material –un tipo de espuma– recobra su forma más rápidamente.

En surf, cada segundo que se gane le facilita al surfista la realización de más maniobras usando la misma ola y, en un campeonato, los atletas tienen poco tiempo para convencer a los jueces, quienes califican potencia, maniobras radicales, fluidez y velocidad. "Una recuperación rápida permite aprovechar mejor la carrera sobre la ola", dijo el también surfista Jordi Solís.

Nuevo material. Hace dos años, Rodolfo González, de Govan Project, se acercó a Lanotec con la inquietud de crear un polímero a partir de derivados vegetales, el cual llegara a sustituir los del petróleo.

Gracias a esto, Govan Project pudo optar por el Fondo PROPYME del Ministerio de Ciencia, Tecnología y Telecomunicaciones (Micitt) y el Consejo Nacional para Investigaciones Científicas y Tecnológicas (Conicit).

Actualmente, se está en proceso de elaboración del prototipo, que estará listo en abril del 2017. Debido a que se tramitará la patente, González no detalló las especies vegetales utilizadas en el polímero, pero sí aseguró que estas se consideran comúnmente malezas y se encuentran con facilidad en el país.

De estas plantas, se extraen compuestos químicos que sirven para generar una molécula conocida como monómero. Estos monómeros se enlazan unos con otros para generar una cadena, que finalmente resulta en el polímero con forma de espuma.

Tal espuma es un poliuretano, material que se usa en diversos objetos como colchones, asientos y zapatos, entre otros.

Aparte de la memoria de forma, el *biofoam* repele el agua. "Si se le hace una agujero a la tabla, la espuma no va a absorber el líquido", detalló González.

Asimismo, el tamaño del poro o celda de este poliuretano es pequeño, lo cual influye en su flotabilidad. "Cuanto más pequeña sea la celda, el *biofoam* tendrá un mejor desempeño", comentó Andrés Baquero, también investigador de Govan Project.

Laboratorio. Govan Project utilizó los equipos de Lanotec para caracterizar las moléculas que se extraen de las plantas y medir el desempeño del material.

Con ayuda del microscopio electrónico de barrido, se estudiaron las celdas y, gracias al reómetro, los investigadores probaron la tensión, compresión y flexión del material.

Con calorimetría de barrido diferencial, se midió la temperatura de fusión, y la espectroscopia infrarroja permitió conocer su composición química.

Se empleó el goniómetro para medir el ángulo de contacto con el agua y se realizó un análisis termogravimétrico para determinar la temperatura de degradación del material.

Aparte del *biofoam*, los investigadores idearon moldes menos pesados que los comerciales, gracias a que incorporaron nanopartículas en estos, las cuales distribuyen mejor las cargas y eso previene lesiones en el operario.

Pruebas en campo. Como los investigadores necesitaban probar el material en el mar, contactaron a dos fabricantes de tablas de surf: Banzaii y All Oceans.

Óscar Urbina (atleta de Banzaii) y Federico Pilurzo (surfista de All Oceans) son quienes probaban las tablas en el agua y su retroalimentación es esencial en la mejora del prototipo, que hoy contiene un 70% de bioplástico.

"En las maniobras aéreas, que cae muy fuerte y otras tablas, incluso se rompen. En cambio, el *biofoam* es muy flexible, funciona muy bien en los cortes, aéreos y tubos", manifestó Urbina.

1 y 2 José Vega les explica a Óscar Urbina y Jordi Solís cómo son las celdas del nuevo poliuretano. 3 Óscar Urbina ya utiliza la nueva tabla de surf. 4 Rodolfo González extrae la espuma del molde, el cual también fue diseñado por Govan Project y Lanotec, mediante la nanotecnología. 5 La espuma fue objeto de una serie de pruebas de laboratorio y de campo. MELISSA FERNÁNDEZ JALIL, EL HARRAR, ÓSCAR URBINA Y GOVAN PROJECT PARA LN

Científicos mejoran tabla de surf hecha en Costa Rica para que sea más amigable con el ambiente

1. Creación u optimización de materiales existentes.
2. Se provee el espacio físico para que la empresa pueda generar su trabajo.
3. Apoyo científico.
4. Estudiantes trabajan con ellos

Empresa: GOVAN:

Poliol modificado (biopoliol) en el prepolímero del isocianato.

Thermal-Mechanical Characterization of Polyurethane Rigid Foams: Effect of Modifying Bio-Polyol Content in Isocyanate Prepolymers

Luis Daniel Mora-Murillo[1], Felipe Orozco-Gutierrez[2], José Vega-Baudrit[2] and Rodolfo Jesús González-Paz[2]*

[1]*School of Chemical Engineering, University of Costa Rica, San Pedro Montes de Oca, San José, Costa Rica*
[2]*National Nanotechnology Laboratory, National Center for High Technology, San José, Costa Rica*

Received November 25, 2016; Accepted February 14, 2017

ABSTRACT: Nowadays, green polyurethane (PU) foams are mostly synthesized by replacing an amount of petrochemical polyol with biobased polyol. Here we report five different families of isocyanate prepolymer formulations that were prepared with biobased sources and the correlation between the structure of chains and the properties of the produced PU foam. Foam behavior in tension, torsion, compression, shape memory tests and physical properties were studied by dynamic mechanical thermal analysis (DMTA); interactions in the polymer chains were analyzed by Fourier transform infrared spectroscopy (FTIR); and thermal analysis was performed by thermogravimetry (TGA) and differential scanning calorimetry (DSC). The results showed that high content of biobased macrotriol in the prepolymer formulation implies a softer final material than commercial polyester polyol foams due to the branched biobased molecules that do not allow enough packaging of the polymer matrix. Moreover, mechanical and thermal properties of the final PU foam are affected by the length, functionality and polarity of the biobased molecules used in the isocyanate prepolymer synthesis.

KEYWORDS: Biobased polyurethane, prepolymer, biodegradable, renewable resources, thermal-mechanical properties

1 INTRODUCTION

Polyurethane (PU) foams are usually obtained by mixing two parts: an isocyanate prepolymer and a polyol mixture of organic molecules containing at least two hydroxyl groups obtained from petroleum. The PU prepolymers consist of a macromolecular chain mixture with many urethane groups in its backbone and an isocyanate reactive group at the chain's end, which allows one to control the viscosity, reactivity and toxicity of the PU component [1]. Secondary reactions can take place when foaming. The reaction between water (blowing agent) and isocyanate groups generates amines and gaseous CO_2, helping the foam growth; these produced amines can also react with the isocyanate to form ureas and isocyanate that can react with themselves in a trimerization reaction to form isocyanurates [2].

Estimated at nearly two billion kilograms in the US alone, PU foams currently account for the largest market among polymeric foams [3]. The versatile properties offered by this material are suitable for use in many fields such as medical devices, coatings and paints, elastic fibers, rigid insulations or flexible and rigid foams. Since petroleum is a nonrenewable source, in recent years there has been increased interest in the synthesis of polymers starting from renewable raw materials, like vegetable oils and natural fats, because of their relevant properties such as availability, low toxicity, sustainability and biodegradability [4, 5].

Considering all of these facts, it is necessary to find alternative routes using natural resources that can help to reduce greenhouse effect emissions in comparison with the fabrication process of conventional polyurethane foams that use raw materials derived from petroleum. The fact that PU foams obtained from natural resources may have biodegradable properties should not be ignored, so the material will also degrade in a more environmentally friendly way [5]. Many studies focused on the synthesis of biobased polymers have tested and reported that vegetable oils are good precursors of polyurethane materials [6–8].

Vegetable oils can be used directly as monomers as found in nature or can be modified with chemicals or

*Corresponding author: rgonzalez@cenat.ac.cr

DOI: 10.7569/JRM.2017.634112

© 2017 Scrivener Publishing LLC

Variation of Physical Properties of Rigid Polyurethane Foams Synthesized from Renewable Sources with Different Commercial Catalysts

Daniel Brenes-Granados[1], Jorge M. Cubero-Sesin[1,2], Felipe Orozco Gutiérrez[3], Jose Vega-Baudrit[3] and Rodolfo Gonzalez-Paz[3]*

[1]*School of Materials Science and Engineering, Costa Rica Institute of Technology, Cartago 159-7050, Costa Rica*
[2]*Institutional Microscopy Laboratory, Costa Rica Institute of Technology, Cartago 159-7050, Costa Rica*
[3]*National Nanotechnology Laboratory (LANOTEC-CeNAT-CONARE), San José, Costa Rica*

Received November 25, 2016; Accepted February 24, 2017

ABSTRACT: In this work, rigid polyurethane foams were synthesized from renewable sources using different catalysts to study their effect on the mechanical, thermal, chemical and surface properties of the foams. A commercial foam pattern was used as the reference pattern to compare the aforementioned properties. Concentrations of the commercial catalysts were optimized to obtain foams with similar mechanical properties to the commercial foam. Morphological characterization of the foams was performed by scanning electron microscopy (SEM). Fourier transform infrared (FTIR) spectroscopy was employed to investigate the characteristic functional groups. Thermal characterization was performed by means of differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Furthermore, mechanical properties were also determined by dynamic mechanical thermal analysis (DMTA). The optimum system of catalysts was composed of 33 Lv and triethanolamine, which achieved a foam with better performance than the commercial foam.

KEYWORDS: Polyurethane foams, catalysts, mechanical properties, renewable sources

1 INTRODUCTION

For decades, the chemical industry has produced polymers based on oil derivatives. As the accessible global oil reserves are dropping, and the ecological footprint that comes along with oil-based materials is increasing, these products are no longer ecologically affordable nor socially accepted. Over the past few years, plenty of efforts have been made for the development of eco-friendly polymers; that is, polymers based on biomass and/or able to biodegrade [1].

Polyurethanes (PUs) are polymers with versatile properties and with a wide range of industrial applications such as medical devices, furniture, coatings, packaging, adhesives, construction materials, fibers, elastomers, paints, and padding [2–4]. More specifically, PU rigid foams are in high demand as thermal insulators for the construction industry [4].

Polyurethanes are complex matrices composed basically of two parts: the *polyol*, which is an organic structure with at least two hydroxyl moieties; and the *prepolymer*, a diisocyanate material that has already been partially reacted with a polyol counterpart to control the viscosity, volatility, reactivity, and toxicity of the PU precursor [5]. When both components are mixed, they react exothermically to form mainly urethane groups (1), covalently bonding the prepolymer and the polyol to form the foam. Other important reactions take place during foaming: a reaction between water and the isocyanate groups that produces amines and gaseous CO_2 that bubbles up through the system and sculpts the foam framework (2); a reaction between the produced amines and the isocyanate to form ureas (3); subsequently, ureas react with isocyanate and form biurets (4) and a trimerization reaction between the isocyanate molecules themselves to form isocyanurates (5) [4, 6]. These reactions are shown schematically in Figure 1.

The chemical and mechanical properties of PU rigid foams are derived from the prepolymer and polyol formulation (isocyanate/hydroxyl molar ratio, length of the polyol chains, molecule rigidity, crosslinking

*Corresponding authors: rgonzalez@cenat.ac.cr

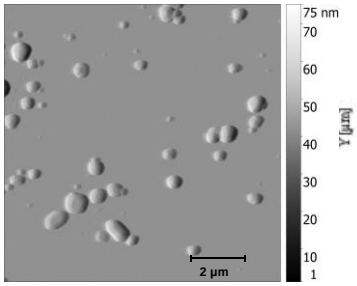
DOI: 10.7569/JRM.2017.634118

© 2017 Scrivener Publishing LLC

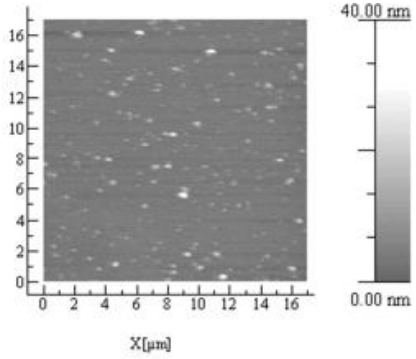
5. Nanopartículas Bioactivas de Extractos Naturales y Tejidos Biomiméticos Nanoestructurados

Dr. Rodolfo Jesús González-Paz

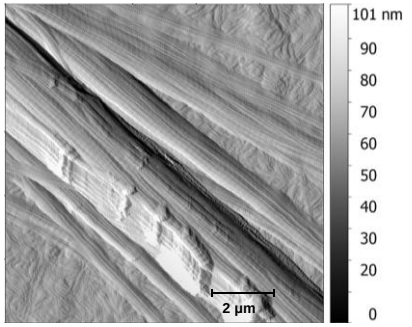
Nanopartículas de Propóleo

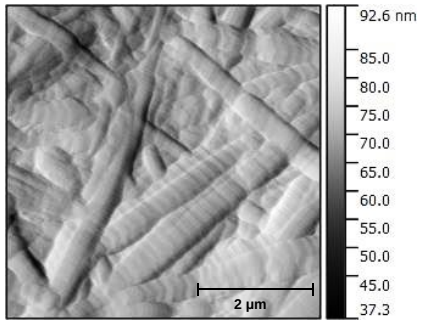


Nanopartículas de Tinospora



INTERACCIÓN TEJIDO-NANOPARTÍCULA (Imágenes de AFM)

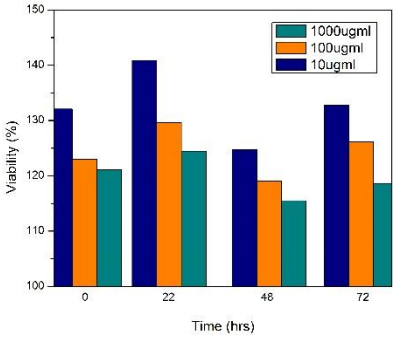


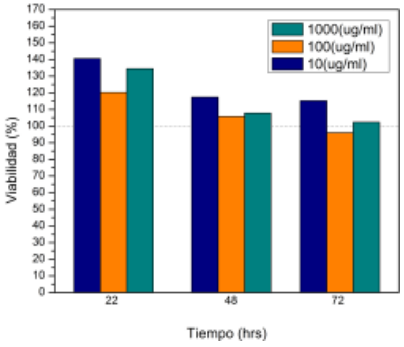


Tejido Biomimético → Tejido Biomimético + Nanopárticula

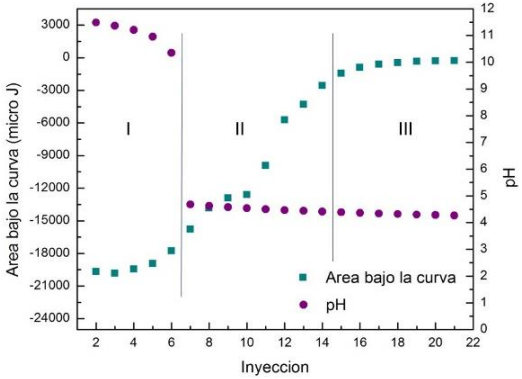
Cambio Morfológico

REGENERACIÓN CELULAR



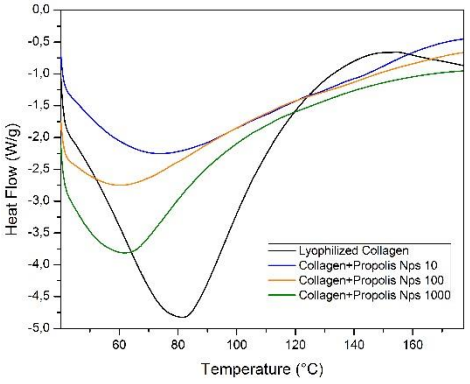


Estudio Termodinámico del Autoensamblaje de Proteinas durante la formación del Tejido



ENSAYO DE NanoITC

ENSAYO DE DSC



Efecto de la nanopartícula sobre la temperatura de desnaturalización de la proteína en tejido.

Nanopartículas de propóleo como plastificante (glicerol y sorbitol)

Production of Starch Films Using Propolis Nanoparticles as Novel Bioplasticizer

Karolina Villalobos[1], Hider Rojas[1], Rodolfo González-Paz[2], Daniel Brenes Granados[2], Jeimmy González-Masís[2], José Vega Baudrit[1,3] and Yendry Regina Corrales-Ureña[1]*

[1]*National Laboratory of Nanotechnology (LANOTEC), National Center of High Technology (CENAT), San José, Costa Rica*
[2]*Instituto Tecnológico de Costa Rica (TEC), Cartago 159-7050, Cartago, Costa Rica*
[3]*National University of Costa Rica (UNA), Heredia, San José*

Received February 02, 2017; Accepted February 02, 2017

ABSTRACT: Because starch is a biodegradable polymer with low cost and wide availability it is an attractive material for producing edible films for fruits. Films produced with pure starch have the disadvantage of being fragile. To overcome this issue, propolis nanoparticles were used as a novel plasticizer. Mechanical, thermal and morphological properties of the films containing 0.5, 1 and 3 wt.% propolis nanoparticles were evaluated. The best performance was obtained using 0.5 wt.% propolis, increasing the Young's modulus and decreasing the glass transition temperature (T_g), showing their plasticizing effect. The results of scanning electron microscopy (SEM) and atomic force microscopy (AFM) images showed a homogenous material with a low quantity of cracks and higher roughness than the pristine starch film. A more hydrophobic material was obtained due to the resin and wax compounds present in the propolis nanoparticles. This study shows the novel use of propolis as plasticizer for starch films.

KEYWORDS: Propolis, starch, plasticizer, antimicrobial agent, bioplastic

1 INTRODUCTION

Many efforts have been made to produce materials from renewable sources due to the environmental problems related to the non-biodegradable waste generated by petrochemical-based polymers and their amount of residues [1]. In the last decade, there has been an increased interest in the production and use of plastics implementing biopolymers as substitutes for synthetic polymers, especially for short-term applications such as food packaging. Different types of renewable sources have been promoted for the development and application of these plastics such as PLA, PHA, PHB, cellulose, and starch. However, these plastics present several limitations like brittleness, thermal instability, poor mechanical properties, among others [2, 3].

Starch has been suggested as a great alternative for producing bioplastics because of its low price, thermoplastic behavior and abundance [4, 5]. It is mainly composed of amylose, a linear polymer, and amylopectin, a highly branched polymer [6]. It is a nontoxic and biodegradable compound. However, the films produced using only starch have poor dimensional stability and mechanical properties caused by high intermolecular forces [1, 7]. Consequently, it is necessary to implement chemical or physical modifications to enhance the functionality of the material. Some strategies used to enhance their mechanical properties are crosslinking, oxidation, acid hydrolysis, ultrasound waves, microwave radiation, annealing and mixture with additives like polyols, sugars, antioxidants, lipids and waxes [1, 8]. Therefore, plasticizers increase flexibility by reducing the intermolecular forces of polymer chains. In this study, propolis will be evaluated as a plasticizer to improve the flexibility of the material. Plasticizers are characterized by their low molecular size, allowing them to integrate the intermolecular spaces between the polymer chains. Therefore, increments of plasticizer can increase the free volume and the molecular mobility [9]. The most common plasticizers for biopolymers are glycerol and sorbitol [6, 10, 11]. These substances, when incorporated into the polymer network, increase the flexibility and workability of the material and also decrease the hardness, density and deformation that lead to an

*Corresponding author: yendry.corrales.urena@gmail.com

DOI: 10.7569/JRM.2017.634109

© 2017 Scrivener Publishing LLC

6. Síntesis verde de nanopartículas de plata

M.Sc Gabriela Montes de Oca

- Menta
- Cas
- Teca
- Yerba Mate

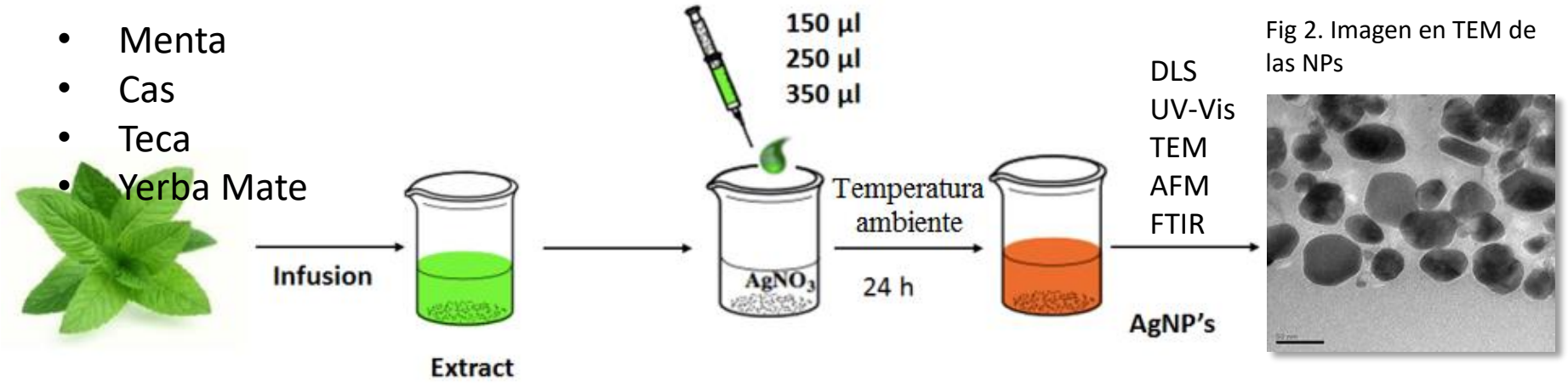
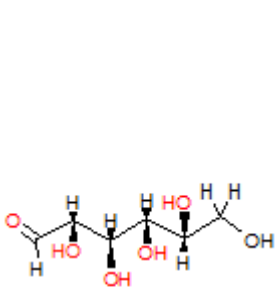


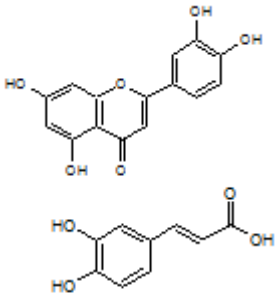
Fig 2. Imagen en TEM de las NPs

Fig 1. Síntesis de nanopartículas por el método de síntesis verde

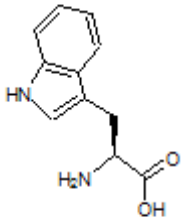
Existen muchos tipos de metabolitos presentes en los extractos naturales involucrados en la síntesis de las nanopartículas



azúcares



polifenoles



aminoácidos

Nanopartículas con actividad antimicrobiana

- *E.Coli*
- *S. aureus*

Revista Green Chemistry, 2017: **Synthesis of silver nanoparticles using natural extracts from yerba mate (Ilex paraguariensis) wastes**.
Colaboración CINDECA, La Plata, LANOTEC.

7. Producción del polímero biodegradable Polihidroxibutirato a partir de desechos de la industria bioenergética

M.Sc Gabriela Montes de Oca

Bacillus megatherium → Utiliza **glicerol** proveniente de la producción de **biodiesel** para su crecimiento. → PHB: producto de alto valor que se puede obtener a partir del glicerol.

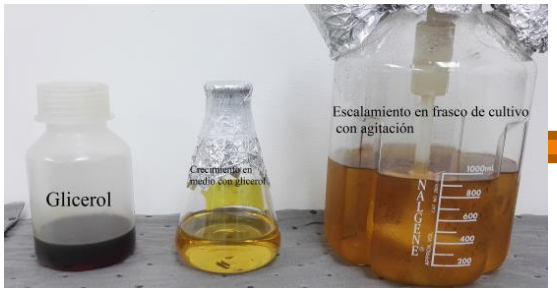


Fig 1. Crecimiento de *Bacillus megaterium* utilizando glicerol (40 g/L).

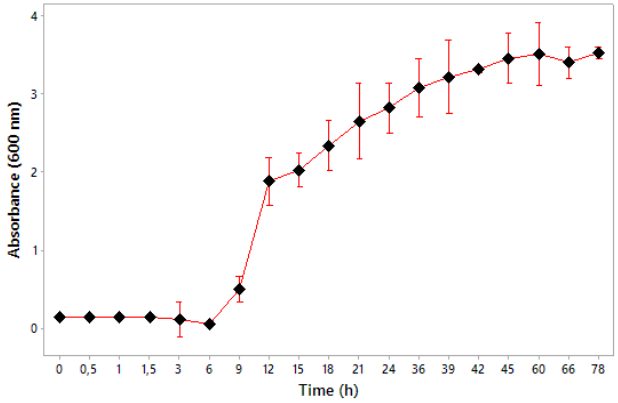


Fig 2. Curva de crecimiento de *Bacillus megaterium* utilizando glicerol 40 g/L.

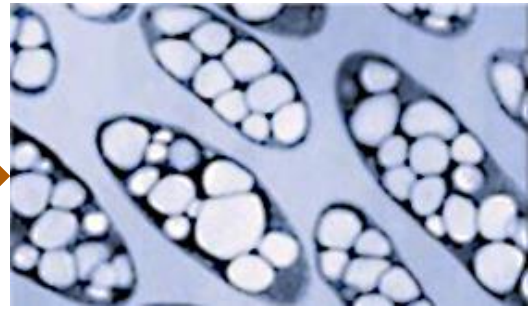


Fig 3. Gránulos de PHB observados en TEM

Obtención de PHB de glicerol residual de la síntesis de biocombustibles

Production of Polyhydroxybutyrate (PHB) by *Bacillus megaterium* DSM 32 from Residual Glycerol of the Bioenergy Industry

Enzo Alvarado-Cordero[1], Gabriela Montes de Oca-Vásquez[2], Reinaldo Pereira-Reyes[2], José Vega-Baudrit[2] and Marianelly Esquivel-Alfaro[1]*

[1]*Laboratory of Science and Technology of Polymers (POLIUNA), Chemistry Department, National University of Costa Rica, Heredia, Costa Rica*
[2]*National Nanotechnology Laboratory, National Center for High Technology, 1174-1200, Calle Costa Rica, Pavas, San José, 10109 Costa Rica*

Received November 11, 2016; Accepted February 23, 2017

ABSTRACT: Biodegradable polymers from renewable resources are generating growing interest in the plastic industry because they have properties similar to synthetic polymers. Polyhydroxyalkanoates, mainly polyhydroxybutyrate (PHB), have mechanical and physicochemical properties very similar to their synthetic counterparts. This work explores the use of residual glycerol from the bioenergy industry for the production of PHB by *Bacillus megaterium* DSM 32. The glycerol works as a source of carbon and energy. Raw glycerol was purified with sulfuric acid in order to neutralize saponified fatty acids. The purification process generated three different phases. One of the phases was the glycerol-rich layer; this layer was filtered and concentrated by vacuum distillation process. The purity of the glycerol was determined by thermogravimetric analysis (TGA). Additionally, the physicochemical properties, like viscosity, pH, ash content and density, were measured. The experiments were conducted in shake flasks at 30 °C and 120 rpm. Different glycerol concentrations (20, 30, 40 g/L) were used to evaluate the influence of the initial concentration of glycerol on the biomass accumulation and biopolymer production. The purified glycerol obtained had a high purity (~ 89.5–92.13%); this material does not contain fatty acids, although it contains ~3.7% salts. The final PHB concentration obtained was 0.054 mg/mL.

KEYWORDS: Polyhydroxybutyrate, glycerol, biopolymer, *Bacillus megaterium*, biomass

1 INTRODUCTION

Due to the increase in oil and natural gas prices, and the high environmental impact generated by synthetic plastics, bioplastics are becoming increasingly more competitive with petroleum-based resins [1]. One alternative to bioplastics is the use of biopolymers such as polyhydroxyalkanoates (PHAs). They have the advantage of being biodegradable and can be produced from renewable resources [2].

The PHAs are a family of biopolyesters of 3, 4, 5, 6 hydroxyacids. These compounds are accumulated as intracellular granules. The PHAs can be synthesized by many Gram-positive and Gram-negative bacteria [3]. These compounds represent an alternative source of energy under limited conditions of some essential nutrients like nitrogen, sulfur and phosphorus and under an excess of available carbon [4]. The use of this polymer by the bacteria is considered a survival strategy in changing environments [1].

Poly-3-hydroxybutyrate (PHB) is the most commonly produced PHA [5, 6]. This polymer is of great commercial and environmental interest as a biodegradable plastic material [7] because of its physical properties, which are very similar to those of the petroleum-based plastics. PHB is a thermoplastic that is free from trace catalysts and other chemical compounds, which makes it a nontoxic material, in addition to being biocompatible [8]. Also, PHB is insoluble in water and is resistant to hydrolytic degradation, which differentiates it from other polymers of biological origin. Its permeability to oxygen is very low, which makes it a suitable material for use in the packaging of products sensitive to oxygen [9].

One strategy for improving the production of PHB is the use of strains capable of synthesizing biopolymer

*Corresponding author: mesquive@una.cr

DOI: 10.7569/JRM.2017.634123

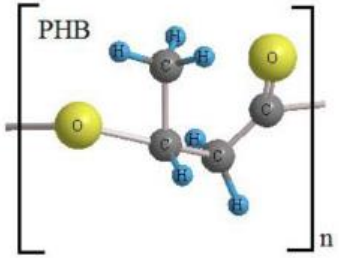
© 2017 Scrivener Publishing LLC

… este PHB se puede usar para….

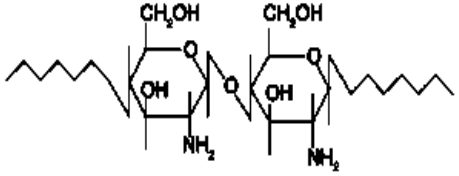
8. Síntesis de nanopartículas para la liberación controlada de fármacos de interés: antibióticos.

M.Sc Gabriela Montes de Oca

La nanotecnología viene a dar un nuevo enfoque para potenciar los agentes antimicrobianos y ayudar a combatir esta problemática de resistencia a los fármacos



Polihidroxibutirato



Quitosano

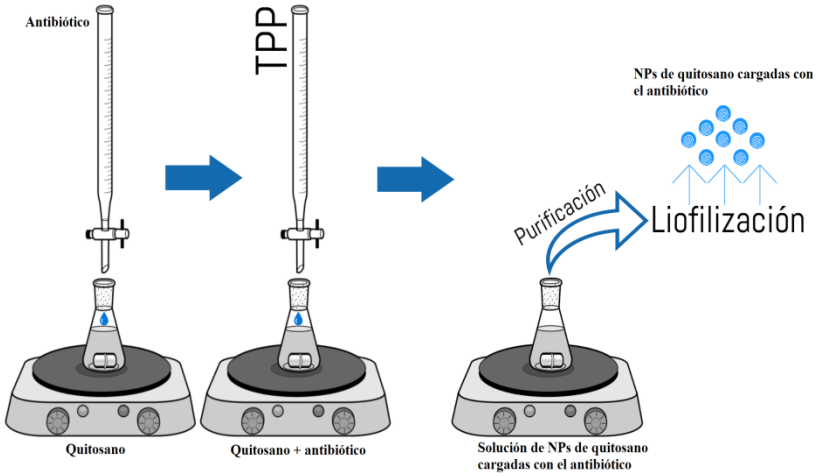


Fig 6. Síntesis de nanopartículas por el método de gelación iónica

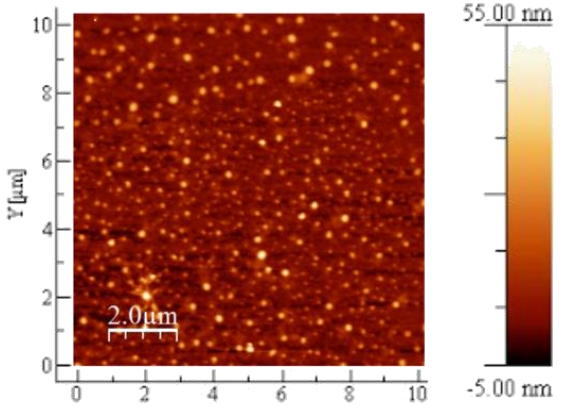


Fig 7. AFM de altura de las NPs

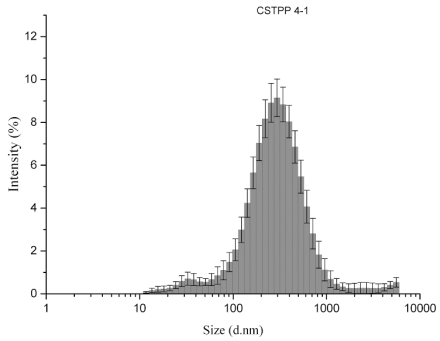
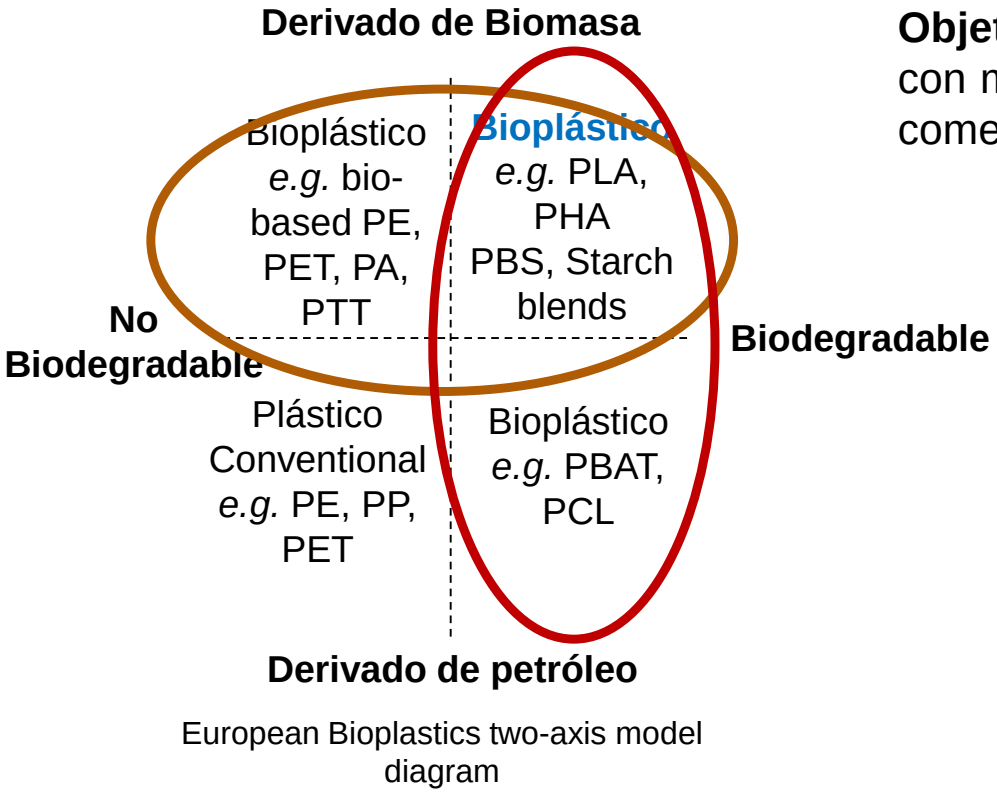


Fig 8. Histograma de distribución de tamaños de las NPs

9. Desarrollo de envases comerciales biodegradables

Dr. Bernal Sibaja



European Bioplastics two-axis model diagram

Objetivo: Producir un envase biodegradable con materiales de origen biomásico para su uso comercial

El interés en los bioplásticos se ha incrementado significativamente debido a precupaciones generadas por el cambio climático, precio del petróleo, entre otros.

http://en.european-bioplastics.org/press/faq-bioplastics/

J Polym Environ (2014) 22:393–397
DOI 10.1007/s10924-014-0667-6

ORIGINAL PAPER

Optimization of Microwave-Assisted and Conventional Heating Comparative Synthesis of Poly(lactic acid) by Direct Melt Polycondensation from Agroindustrial Banana (*Musa AAA* Cavendish) and Pineapple (*Ananas comosus*) Fermented Wastes

Pablo Jiménez-Bonilla · Jessica Salas-Arias · Marianelly Esquivel · Jose Roberto Vega-Baudrit

Published online: 25 June 2014
© Springer Science+Business Media New York 2014

Abstract In Costa Rica, a lot of pineapple (*Ananas comosus*) and banana (*Musa AAA*) agroindustrial residues are generated each year. These residues can be used to obtain L-lactic acid by fermentation, ultrafiltration and electrodialysis. Poly(L-lactic acid) (PLLA) is a biodegradable and renewable polyester with many industrial and biomedical applications. There is a growing interest to improve the energetic efficiency of the synthesis of PLLA, because the main issue to produce this polymer is the high productive cost compared with petrochemical traditional commodities. In this research, the synthesis of PLLA through two different techniques was compared: microwave-assisted and conventional heating. On microwave synthesis the best results were obtained using lower temperatures and lower reaction times than the conventional heated synthesis. The reaction time was reduced from 15 h by conventional heating to 4.5 h using microwave-assisted synthesis.

Keywords Microwave-assisted synthesis · Poly(lactic acid) · Biodegradable polymer · Pineapple wastes · Banana wastes · Green chemistry

Introduction

In the last years, the two major export products in Costa Rica were the banana (*Musa AAA*) and the pineapple (*Ananas comosus*). The agro-industrial banana and pineapple wastes have been an environmental problem. These wastes are a carbohydrate source and these can be used to produce fermentative derivatives. Recently, a process for production of 15–16 g/100 mL L-lactic acid from agroindustrial wastes was developed, by means of an enzymatic pretreatment, lactic fermentation, nanofiltration and electrodialysis purification [1].

There are two traditional ways to polymerize the lactic acid: the ring opening polycondensation and the direct melt polycondensation. The ring opening method consists of synthesizing a dimeric cyclic compound (lactide), which can be polymerized through further chemical reactions; the direct melt polycondensation does not need an intermediate compound, and produce a low molecular weight polymer [2–6]. Some of the advantages of the ring opening polymerization method are the higher molecular weight, as well as the purity of the lactide obtained by sublimation. The advantages of the direct melt polycondensation method are the lower production cost and the easier experimental procedure. Scheme 1 shows the two ways to obtain poly (L-lactic acid) (PLLA).

The poly(L-lactic acid) is a biodegradable and biocompatible polymer. PLLA is considered the first biodegradable polymeric commodity, because the PLLA properties which are comparable with polyethylene and polypropylene resins.

P. Jiménez-Bonilla (✉)
Laboratory of Natural Products and Biological Assay (LAPRONEB), Chemistry Department, Natural and Exact Sciences Faculty, National University, Omar Dengo Campus, 86-3000 Heredia, Costa Rica
e-mail: pabloijb@hotmail.com

J. Salas-Arias · M. Esquivel
Polymer Research Laboratory (POLIUNA), Chemistry Department, National University, 86-3000 Heredia, Costa Rica

J. R. Vega-Baudrit
National Laboratory of Nanotechnology (LANOTEC), CeNAT, Pavas, Costa Rica

microonda

Proyecto: FIFCO

2 etapas:

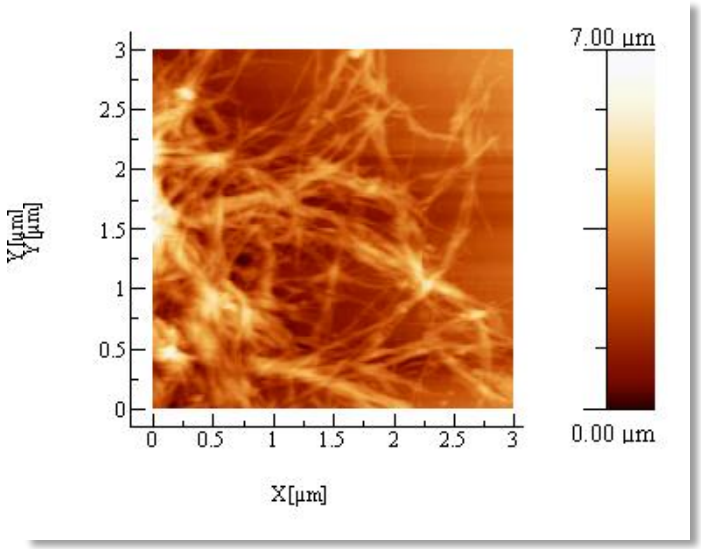
1. Estudiantes emprendedores: premio $32 000.
2. Etapa grande: $ 350 000.

FIFCO

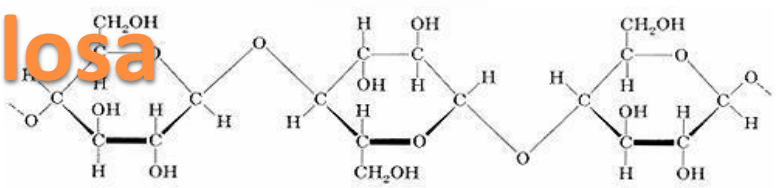
10. Nanocellulose extracted from pineapple peels and banana waste.

Dra. Yendry Corrales

Nanocellulose: AFM



Actuales usos de la celulosa



Acetato de celulosa: vidrios de seguridad.

Rayon (textiles)

Nitrocelulosa (explosivos)

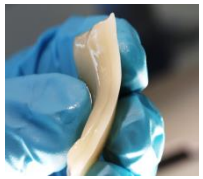
Espesante
Emulsificante

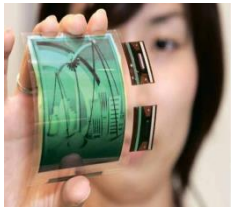
Metilcelulosa: alimentos y fármacos

Potencial de nanocelulosa

Cobertores
Mercado de $8,2 billones
(4,2% crecimiento anual)

Medicina



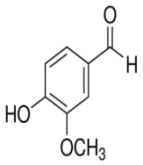


Láminas flexibles (pantallas, baterías), por IBM

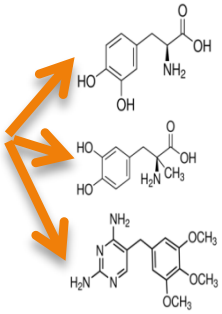
También: Pinturas, barnices, recubrimient hidrogeles.

Usos de la lignina

Materia prima:



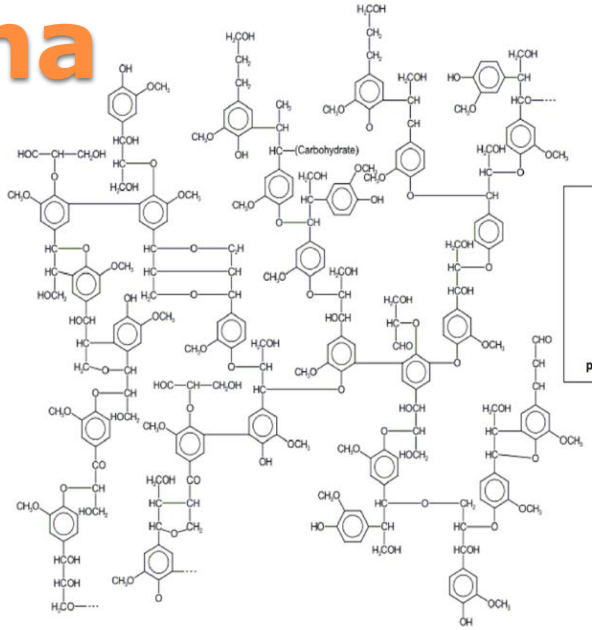
Vainillina

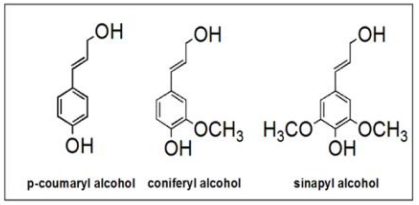


L-Dopa

L-methyldopa

Trimethoprim



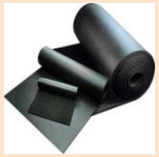


Dispersante:

-Insecticidas, herbicidas.
- Cementos, cerámicas
- Pigmentos

Emulsificante, estabilizador:

- Asfaltos, suelos
- Hule, latex, foam



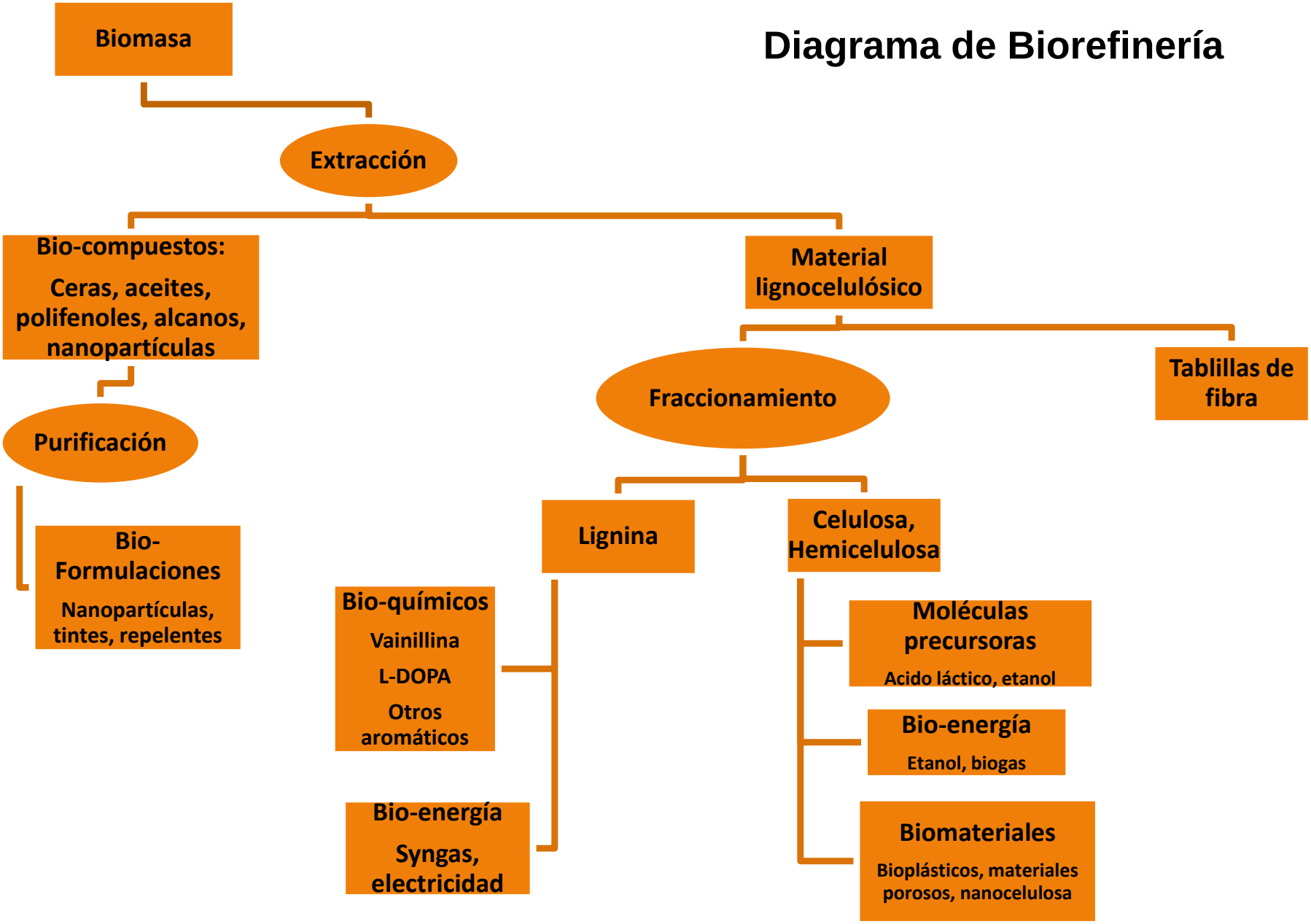
Adherente:

- Tintas
- Laminados

Secuestrante de metales:

- Aguas industriales
- Micronutrientes en agricultura

Diagrama de Biorefinería



Synthesis and Characterization of Nanocrystalline Cellulose Derived from Pineapple Peel Residues

Melissa Camacho[1], Yendry Regina Corrales Ureña*[,1], Mary Lopretti[2], Leonel Bustamante Carballo[1], Galia Moreno[1], Brian Alfaro[1] and Jose Roberto Vega Baudrit[1,3]

[1]*National Laboratory of Nanotechnology, CENAT, Pavas, San José Costa Rica*
[2]*University of the Republic (UdelaR), Av. 18 de Julio 1824-1850, 11200 Montevideo, Departamento de Montevideo, Uruguay*
[3]*National University of Costa Rica UNA, Heredia, Costa Rica*

Received November 25, 2016; Accepted February 24, 2017

ABSTRACT: Pineapple peel biomass was used as raw material for nanocellulose extraction. The raw material is a residue from the Costa Rican fruit industry. The nanocellulose was obtained by a two-step hydrolysis process. Firstly, the cellulose was hydrolyzed with HCl to obtain microcrystalline cellulose. In the second step, the hydrolysis was carried out using H_2SO_4 to obtain smaller fragments and decrease the lignin content. A time-dependent study was carried out to determine the particle size decrease depending on the contact time with the H_2SO_4. The chemical, thermal and morphological properties were analyzed by Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), dynamic light scattering (DLS), zeta potential, atomic force microscopy (AFM) and scanning electron microscopy (SEM). The nanofiber-like cellulose was obtained after 60 minutes of exposure to 65 wt% H_2SO_4.

KEYWORDS: Nanocellulose, pineapple peels, acid hydrolysis, waste

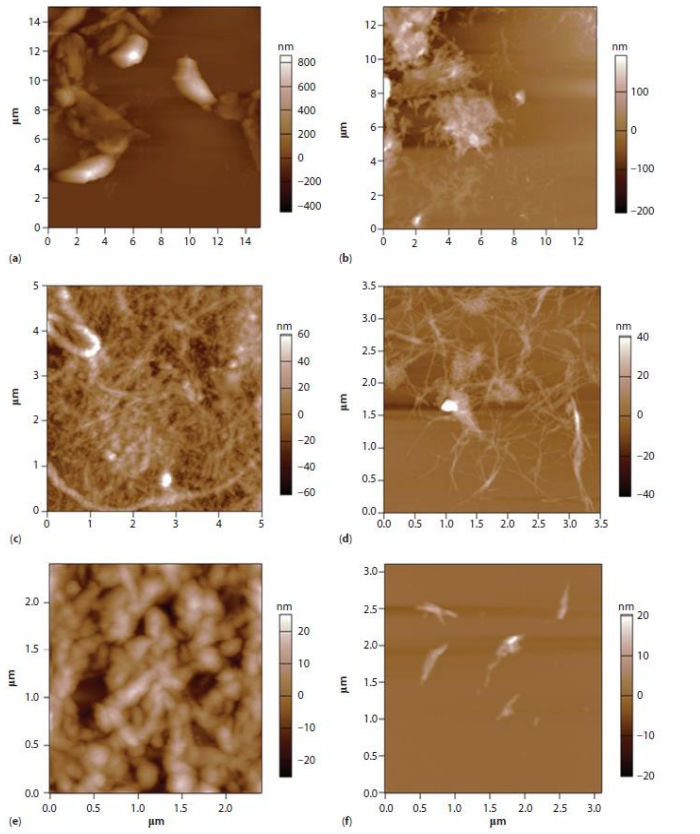
1 INTRODUCTION

Cellulose is the most abundant natural polymer on earth's surface, and it's the primary component that provides stiffness and strength to plant structure. Roughly a third of the plant's anatomy is composed by cellulose, and each year 1000 tons are produced by natural synthesis [1–3]. Since cellulose is highly available, biodegradable, naturally renewable and biocompatible, it has become a material of particular relevance among scientists and material developers [1]. Because of these properties, it has been proposed as an alternative material to substitute petroleum-based polymers [2–4]. In Latin America, the pulp and juice of pineapples are exported while the shells remain in the country. These pineapple peels constitute a rich source of cellulose [5]. Fibers composed by cellulose constitute 19 wt% of the fruit and are composed of cellulose, hemicellulose and lignin; making it a potential material for obtaining nanocrystalline cellulose (NCC) due to the large amount of residues generated by agricultural industries [6].

Cellulose is a linear carbohydrate polymer composed of β-glucopyranose units linked by glycosidic bonds. The NCC has a fiber-like and rod-like structure; therefore, it is crystalline [7]. Crystalline structures are formed by intra- and intermolecular hydrogen bonds [8]. The molecular length and properties depend on the natural source [9]. The particles length and width falls within the range of 200–500 nm and 5–10 nm, respectively [10].

Nanocrystalline cellulose exhibits many physicochemical qualitites that confer unique properties such as high bending strength (~10 GPa), a Young's modulus of approximately 150 GPa, high aspect ratio and specific surface area. Consequently, it has been used as reinforcement for polymer matrices [11]. Additionally, the surface of NCC is covered with polar groups such as hydroxyl groups, which provide high moisture adsorption capacity and surface reactivity [12]. Nanoparticles derived from cellulose present a strong potential as stabilizers for oil-water suspensions (fats in toppings, salad dressings and sauces) [2], as reinforcement [13], drug delivery excipient, enzyme immobilization and scaffold for tissue engineering [12, 14] and biosensors [15], among others.

Acid hydrolysis of cellulose is the most common process for obtaining NCC. The amorphous fraction



gure 4 AFM images of the product obtained after hydrolysis of the microcellulose with H_2SO_4: (**a**, **b**) 0 min (microcellulose), , **d**) 60 min, and (**e**, **f**) 75 min.

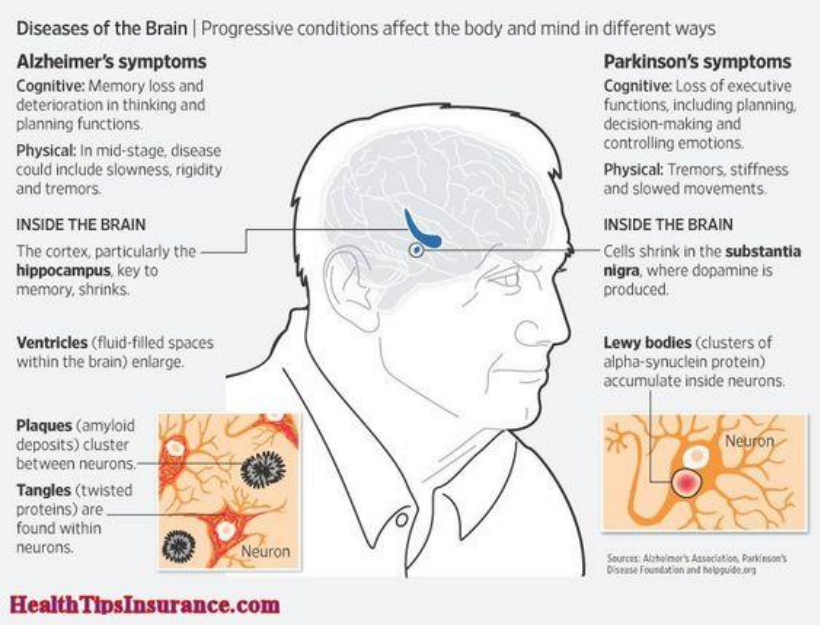
*Corresponding authors: yendry.corrales.urena@gmail.com

DOI: 10.7569/JRM.2017.634117

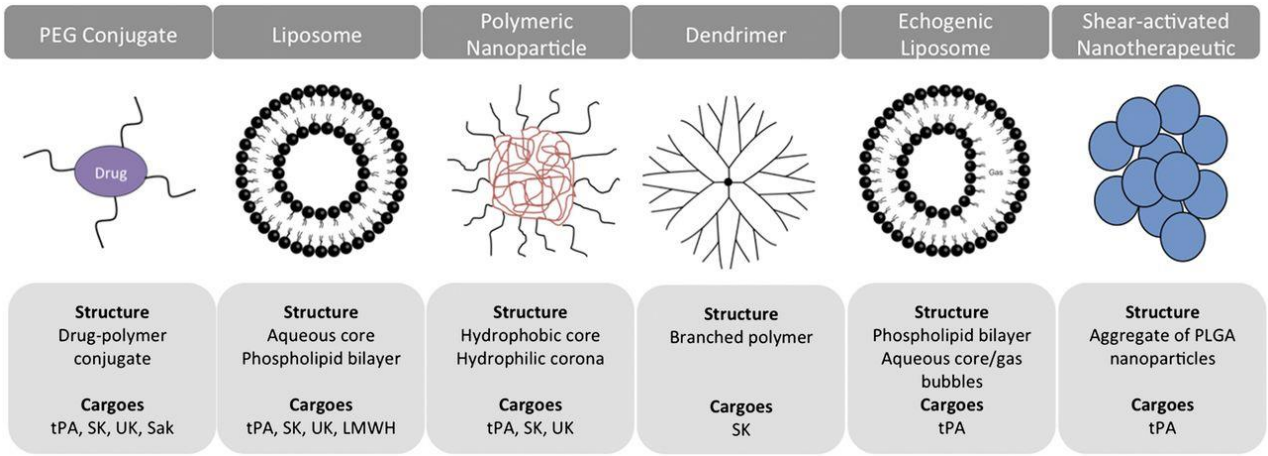
© 2017 Scrivener Publishing LLC

11. Desarrollo de sistemas de liberación de fármacos para mitigar las consecuencias de enfermedades neurodegenerativas

Dr. Bernal Sibaja



Objetivo: Desarrollo de nanomedicinas y sistemas nanométricos de transporte de agentes activos para mitigar los efectos de enfermedades como el **Parkison, Alzheimer, ELA**, etc.

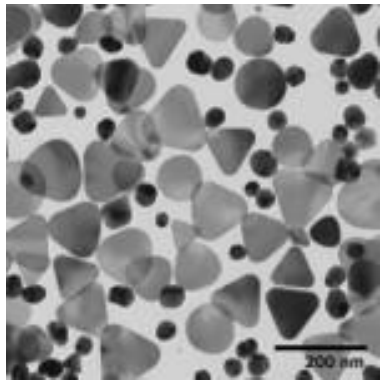


https://s-media-cacheak0.pinimg.com/564x/b1/31/48/b13148dd7729cd897e78fecca548231c.jpg

12. Nanotecnología aplicada al combate de mosquitos vectores de enfermedades como Dengue, Malaria, Zika.

Dr. Bernal Sibaja

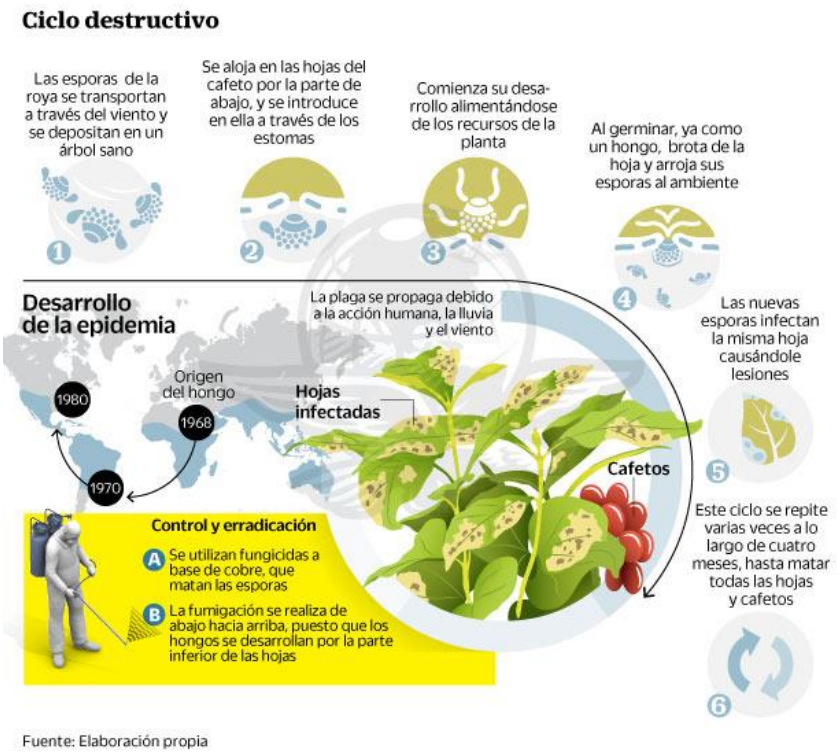
Objetivo: Síntesis de nanopartículas y nanocristales metálicos a partir de extractos con plantas con actividad contra artropodos para mitigar las enfermedades que transmiten.



http://ichef-1.bbci.co.uk/news/ws/624/amz/worldservice/live/assets/images/2016/01/25/160125171559_zika_virus_map_624.png

13. Desarrollo de sistemas para el control del hongo *Hemileia Vastatrix* (roya) en plantaciones de café

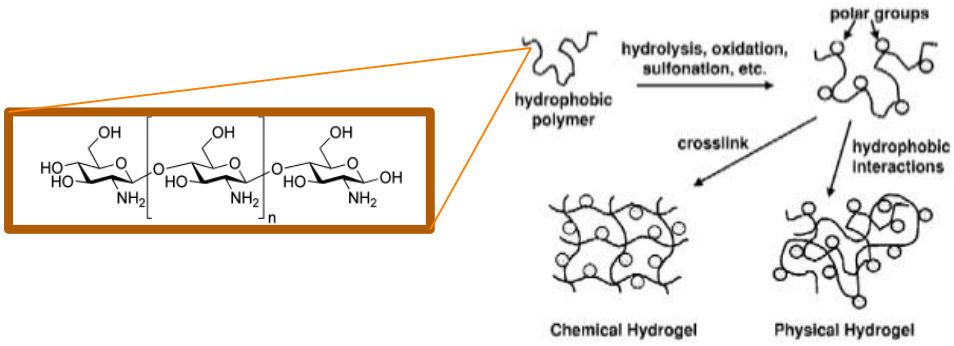
Dr. Bernal Sibaja



Fuente: Elaboración propia

Para los meses de septiembre y octubre, la cantidad de roya en las parcelas del Valle Central y el Occidental de Costa Rica se ha reportado un aumento del 30% en la incidencia de la roya en el café.

Objetivo: Desarrollo de un sistema de liberación de agentes activos que mitiguen el avance, asi como el número de dosificaciones de fungicidas, contra la roya utilizando biopolímeros



http://archivo.eluniversal.com.mx/graficos/include/int_roya.jpg

Bio-inspired emerging technologies

Nueva área: **“ Nanobiodiversidad "**

14. Study of the interaction of nanomaterials with complex ecosystems using the mangrove forest as a model

Dra. Yendry Corrales

http://www.aguiladeosa.com/sierpe-terraba-guided-mangrove-tour/

Nanobiodiversity: The Potential of Extracellular Nanostructures

Felipe Orozco[1‡], Brian Alfaro-González[1‡], Yendry Corrales Ureña[1], Karolina Villalobos[1], Angie Sanchez[1], Francisco Bravo[1], José Roberto Vega[1] and Orlando Argüello-Miranda[1*]

[1]*National Laboratory of Nanotechnology, National Center of High Technology CENAT, San José, Costa Rica*

[‡]*Present address: University of Texas Southwestern Medical Center, Dallas, Texas, USA*

Received November 25, 2016; Accepted January 23, 2017

ABSTRACT: As an outcome of millions of years of evolution, biological systems have developed different methods to interact with their surroundings. Many of these adaptations, such as secretions, light-interacting surfaces, biochemical active compounds, and many other survival strategies, are phenomena occurring at the nanometric scale. In this review, we describe how extracellular nanometric structures are responsible for manipulating energy and matter, creating some of the emergent properties of life. Iridescent colors in birds' feathers, the manipulation of wettability of insects' exoskeletons, the adhesive properties of nanopatterned secretions and the ability to polarize light are examples of the potential of extracellular nanostructures. We defined the study of extracellular nanostructures as "nanobiodiversity," a unifying concept that emphasizes the inspiration that life at the nanoscale offers, not only for designing new materials, but also for its understanding.

KEYWORDS: Extracellular structures, biomimetic, biodiversity, nanopatterns, nanobiodiversity, evolutionary biology and bio-nanotechnology

1 INTRODUCTION

Life on earth encompasses not only an astounding number of genetic and biochemical pathways, but also a plethora of emergent structures at the nanometric scale [1]. Nanostructures are ubiquitous throughout the phyla and achieve a variety of functions that support the survival of the species. Conservatively assuming a figure of 8 million extant species on our planet [2], each one producing at least one type of extracellular nanostructure, then it is likely that the most varied forms of naturally occurring nanostructures are of biological origin. Precisely speaking, the replication and perpetuation of cells depends on several intracellular nanometric structures (INS), which are in charge of moving chromosomes, shaping the cell membrane, producing energy and replicating the genome [3]. Most of the 20th century cell biology and biochemistry has successfully unraveled the principles upon which these nanomachines work in coordination to produce life. By contrast, much less is known about extracelullar nanometric structures (ENS) which function at interfaces between living systems and their environment. For instance, we can reconstitute large protein complexes and explain how they are able to replicate DNA, create microtubules and remodel membranes; however, we are just beginning to understand the synthesis of a diatom silicon shelve or the mechanisms that ensure the faithful disposition of nanometric structures in feathers, the eye lenses of insects, and the emergent properties of some extracellular exudates [4]. Paradoxically, despite the great variety of organic nanostructures produced by living beings, there is no unifying concept to describe the aim of understanding and characterizing the extracellular nanometric structures. The goal of this review is to propose a concept that specifically defines the study of the extracellular nanostructures produced by living systems: Nanobiodiversity.

*Corresponding author: alejandrolvido@gmail.com

‡both authors contributed equally to this work

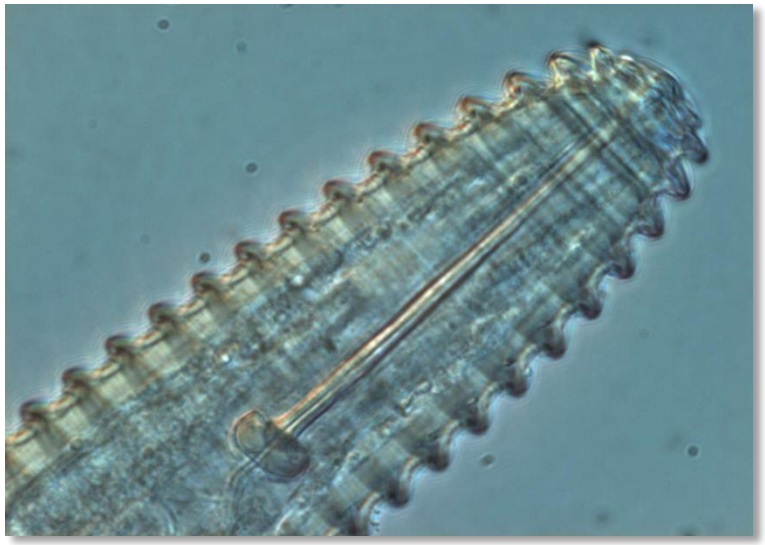
DOI: 10.7569/JRM.2017.634110

© 2017 Scrivener Publishing LLC

15. A nanotechnological approach for control of nematode pest

Dra. Yendry Corrales

Nematode



Stylet

- Not clear how they’re attracted to the roots.
- Trabajo con la empresa Bayer de Alemania.

16. Identification of adhesive and antimicrobial principles of the onychophorans worms using nanotechnology techniques

Dra. Yendry Corrales

onicóforos

Barnacles

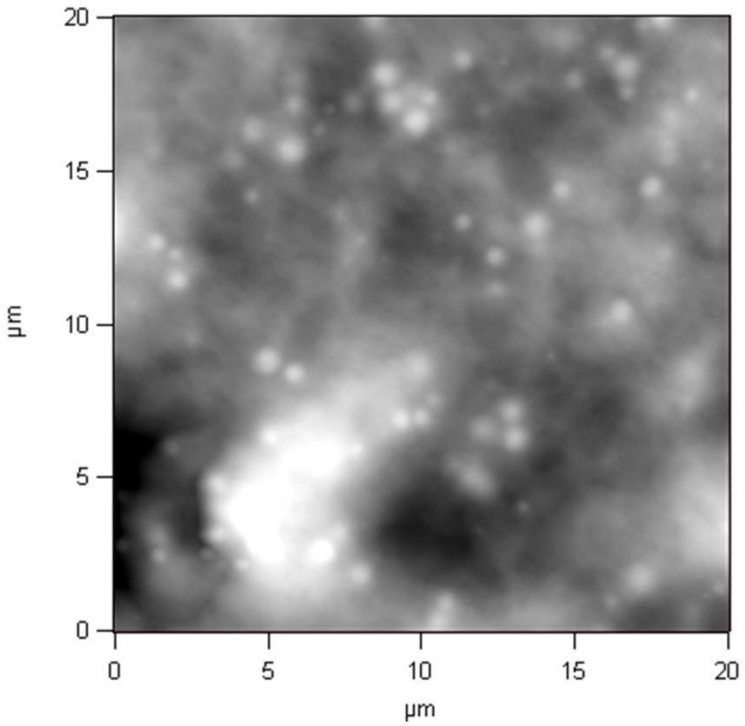
Velvet worms

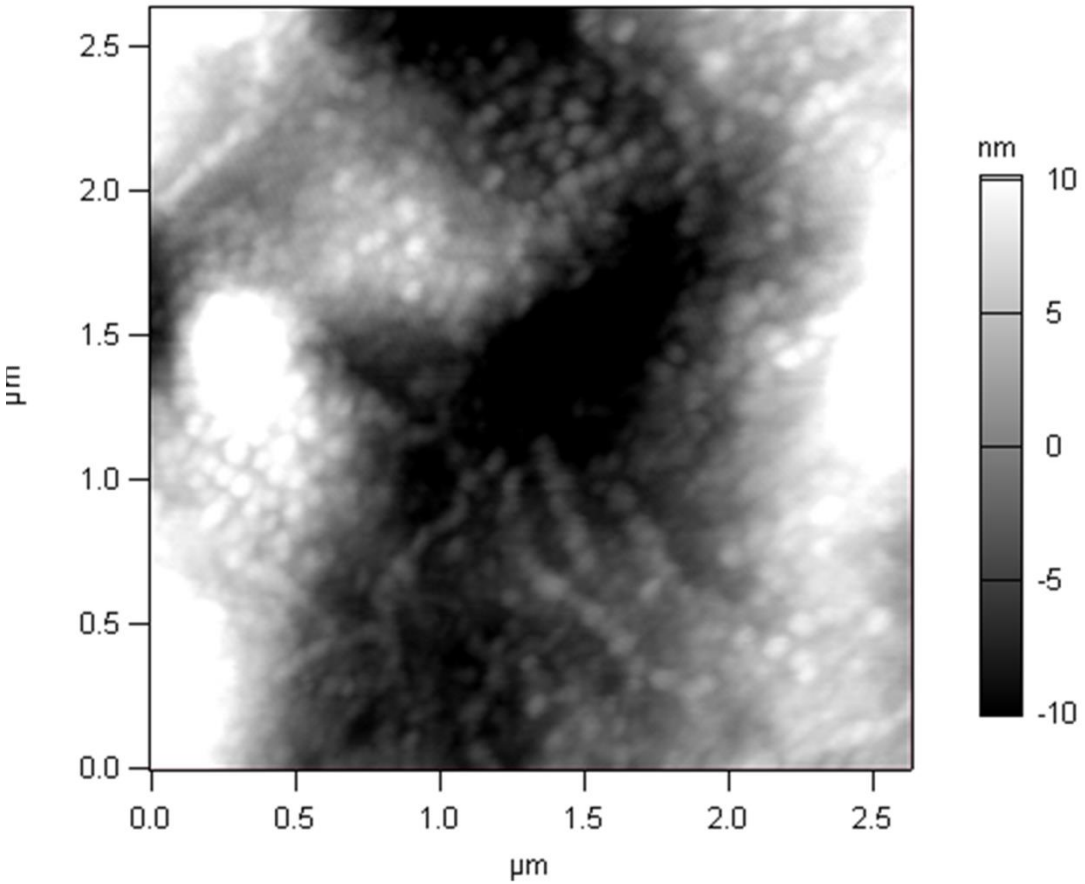
Identification of adhesive principles in Costa Rican biodiversity

J Zoolog Syst Evol Res (2014) 52 (4), 265--272

http://5cense.com/costarica/CR23.htm

Height images, AFM

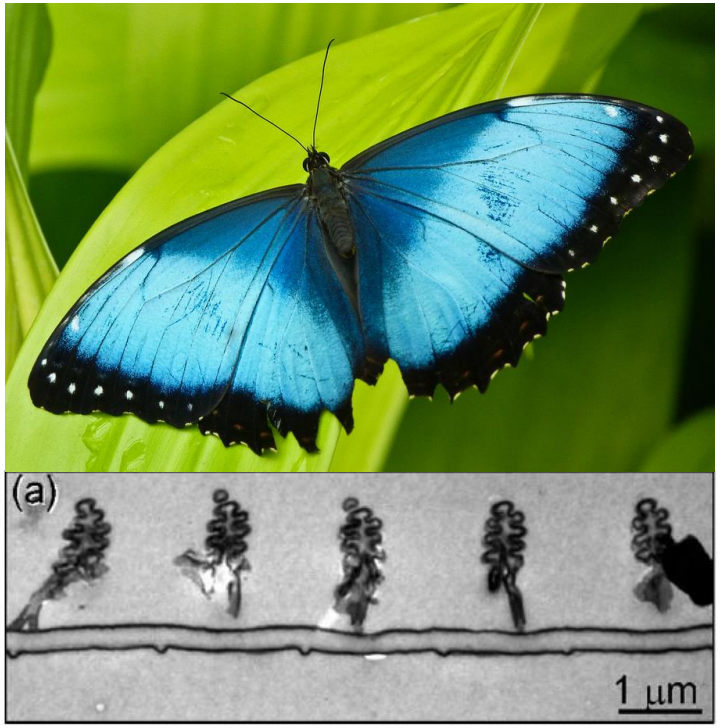




17. STRUCTURAL COLOR OF COSTA RICAN BIODIVERSITY

BQ Felipe Orozco

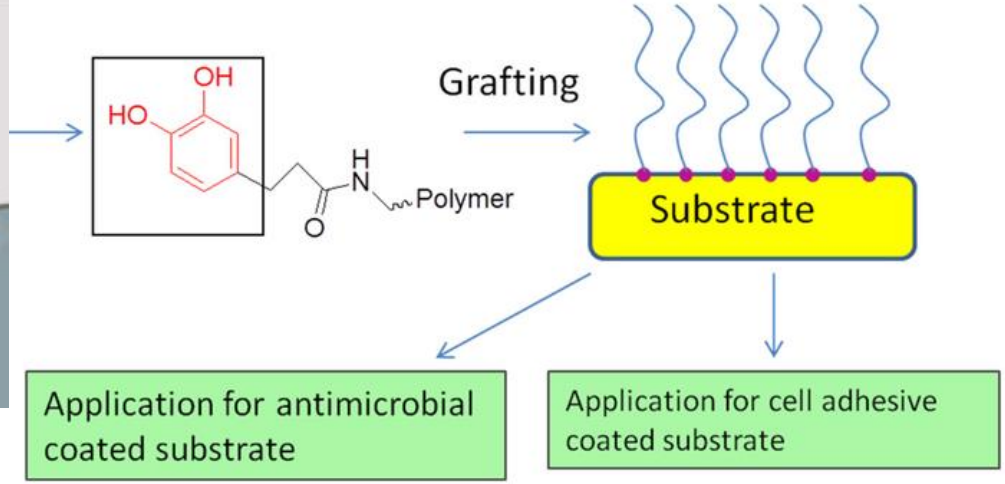
Ding, Y., Xu, S., & Wang, Z. L. (2009). Structural colors from Morpho peleides butterfly wing scales. *Journal of applied physics*, *106*(7), 074702.



Forster, J. D., Noh, H., Liew, S. F., Saranathan, V., Schreck, C. F., Yang, L., ... & Cao, H. (2010). Biomimetic isotropic nanostructures for structural coloration. *Advanced Materials*, *22*(26-27), 2939-2944.

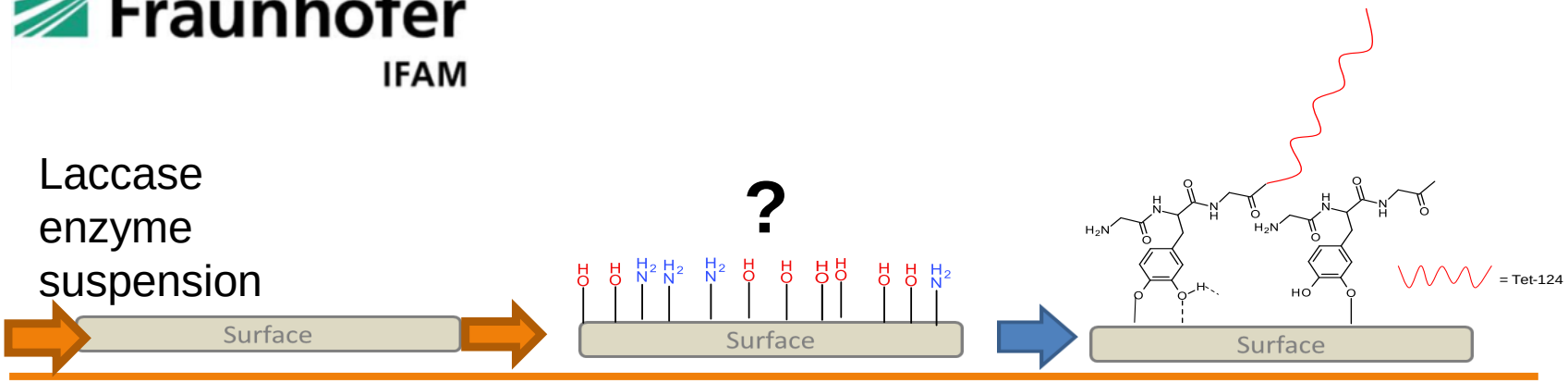
18. Green chemistry immobilization method

Dra. Yendry Corrales



Fraunhofer
IFAM

Laccase enzyme suspension



CeNAT®
Centro Nacional de Alta Tecnología

LANOTEC
Laboratorio Nacional de Nanotecnología

19. Volcanic nanoparticles and microparticles

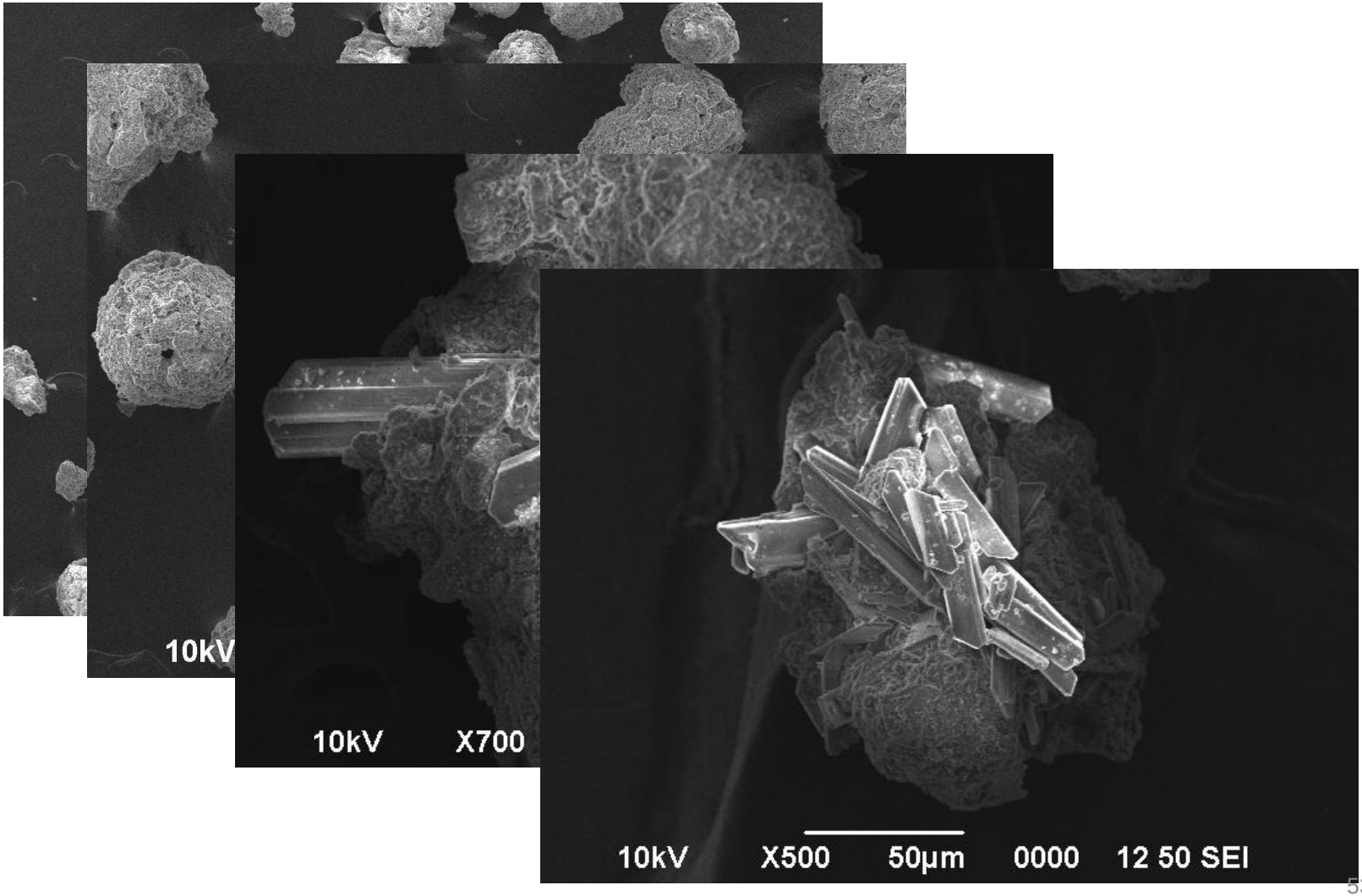
Dra. Yendry Corrales, Biol. Rey Pereira

Turrialba Volcano

Which is the morphology of the particles?
Which is the chemical composition?
Which is the impact of this material at the farms?
Do these materials catalyze reaction?

CeNAT®
Centro Nacional de Alta Tecnología

LANOTEC
Laboratorio Nacional de Nanotecnología



ALDEA GLOBAL

investigadores están caracterizándola, según su morfología y cuerpos

Ceniza del Turrialba tiene forma de palomita de maíz

LA CIENCIA DEL TURRIALBA

Estudio es útil para entender el volcán, conocer impacto en salud y desarrollar nuevos materiales

Especial muestra la ciencia detrás del coloso

20. Proyecto Horizonte 2020

- Development of experimental cellular models and procedures with immunoglobulins (IgGs) from patient sera as diagnostic and prognostic technologies related to neurodegenerative diseases, NDs (particularly based on amyotrophic lateral sclerosis - ALS research).
- Defining mark-up characteristics of the standardized in vitro approach for personalized diagnostic protocols for NDs.
- Design of a small-scale platform based on automated fluorescence microscopy.

Marie Skłodowska-Curie Actions (MSCA)
Research and Innovation Staff Exchange (RISE)
H2020-MSCA-RISE-2017
Project Acronym: AUTOIGG – Project Number: 778405

Sistema de diagnóstico para enfermedades neurodegenerativas

21. OTROS PROYECTOS.

Materials Chemistry and Physics 200 (2017) 331–341

Contents lists available at ScienceDirect

Materials Chemistry and Physics

journal homepage: www.elsevier.com/locate/matchemphys

Cholic acid covalently bound to multi-walled carbon nanotubes: Improvements on dispersion stability

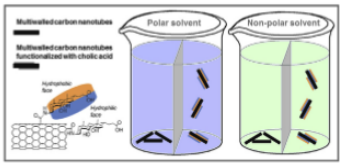
C. Redondo-Gómez [a, b], F. Orozco [a], P.-L. Michael Noeske [c], V. Soto-Tellini [d], Y.R. Corrales-Ureña [a, *], J. Vega-Baudrit [a]

[a] National Laboratory of Nanotechnology LANOTEC, San José, Costa Rica
[b] School of Engineering and Materials Science, Queen Mary University of London, Mile End Road, E1 4N, London, United Kingdom
[c] Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Wiener Strasse 12, 28359, Bremen, Germany
[d] Escuela de Química, Centro de Investigaciones en Electroquímica y Energía Química (CELEQ), Universidad de Costa Rica, San Pedro, Costa Rica

HIGHLIGHTS

- MWCNT functionalized with cholic acid formed stable dispersions in aqueous and organic polar and low-polarity solvents.
- Biomimetic functionalization approach using cholic acid.
- Chemical route for covalently functionalization of the MWCNT with bile salts were presented.
- Micellar structures attached to the MWCNT surface stabilized the nanotubes.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 30 March 2017
Received in revised form
7 July 2017
Accepted 31 July 2017
Available online 1 August 2017

Keywords:
Multiwalled carbon nanotubes
Amphiphilic
Cholic acid
Covalently bound

ABSTRACT

Despite the vast volume of literature regarding the interaction between carbon nanotubes and surfactants, the effect of the covalent attachment of an amphiphilic surfactant based on a biomimetic approach to multiwalled carbon nanotubes (MWCNT) has not been explored. In this report, the functionalization of the MWCNT surface with cholic acid by a chemical route is described. A three-step MWCNT chemical modification route was carried out and the properties of the intermediate and final materials were evaluated employing X-ray photoelectron spectroscopy (XPS), transmission electron microscopy (TEM), atomic force microscopy (AFM) and zeta potential measurements. After functionalization, the MWCNT showed a facial bio-amphiphilic behavior; improving the dispersion stability as compared to commercial and oxidized MWCNT. The resulting material preserved the pristine multi-walled structure and originated surprisingly stable dispersions in aqueous and organic polar and low-polarity solvents.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

Carbon nanotubes are perhaps the most studied carbon allotrope to date [1]. MWCNT were the first kind of carbon nanotubes to be reported and they have demonstrated to be impressively versatile and functional nanoscaffolds with fine-tunable thermal, optical, mechanical and chemical properties [2]. Since the discovery of MWCNT a [3] series of approaches to provide them with chemical functionalities have been explored including covalent [4–6], non-covalent [7–10], and mixed [6,11] strategies, leading to a vast number of applications as catalytic [12], electronic [13], sensing

* Corresponding author.
E-mail address: yendry386@hotmail.com (Y.R. Corrales-Ureña).

http://dx.doi.org/10.1016/j.matchemphys.2017.07.089
0254-0584/© 2017 Elsevier B.V. All rights reserved.

Sales biliares: ácido cólico sobre NTCPM: biomimetismo. Comportamiento bioanfifílico

BASIC RESEARCH-LABORATORY

Evaluation of Microleakage by Gas Permeability and Marginal Adaptation of MTA and Biodentine™ Apical Plugs: *In Vitro* Study

Evaluación de la microfiltración por permeabilidad de gas y adaptación marginal de tapones apicales de MTA y Biodentine™: Estudio *in vitro*

Karen Brenes-Valverde DDS[1]; Elian Conejo-Rodríguez PhD[2]; José Roberto Vega-Baudrit PhD[3]; Mauricio Montero-Aguilar MSc[4]; Daniel Chavarría-Bolaños MSc, PhD[5]

1. Posgrado de Odontopediatría. Facultad de Odontología, Universidad de Costa Rica, Costa Rica.
2. Centro de Investigación en Ciencias Atómicas, Nucleares y Moleculares (CICANUM), Universidad de Costa Rica, Costa Rica.
3. Laboratorio Nacional de Nanotecnología (LANOTEC), Centro Nacional de Alta Tecnología (CeNAT) San José, Costa Rica.
4. Departamento de Ciencias Restaurativas, Facultad de Odontología, Universidad de Costa Rica, Costa Rica.
5. Departamento de Ciencias Diagnósticas y Quirúrgicas, Facultad de Odontología, Universidad de Costa Rica, Costa Rica.

Correspondence to: Dr. Daniel Chavarría Bolaños - daniel.chavarria@ucr.ac.cr

Received: 1-V-2017 Accepted: 15-V-2017 Published Online First: 16-V-2017

DOI: http://dx.doi.org/10.15517/ijds.v0i0.28952

ABSTRACT

The endodontic treatment of teeth with incomplete development is always a complex task. Nowadays, biomaterials such as bioceramics offers promising clinical evidence that supports its use. However, the standardization of its use for apexification purpose still needs a deeper understanding of the materials' behavior. The aim of this investigation was to evaluate the marginal adaptability and microleakage by gas permeability of MTA and Biodentine™ apical plugs in an *in vitro* model. Materials and methods: Twenty-four single rooted human teeth were selected according to previously stablished inclusion criteria. All samples were prepared obtaining standard cylindrical internal canals with a diameter of 1.3 mm. Root canals were gently rinsed using 5.25% sodium hypochlorite and EDTA 17%. The apical 3mm and remaining coronal dental structure were sectioned to obtain 10mm roots. Roots were randomly assigned to 3 different groups as follows: GROUP A: MTA (n=10), GROUP B: Biodentine™ (n=10) and Group C: Control (positive n=1, negative n=3). MTA and Biodentine™ were prepared according to manufacturer's indications, and apical plugs of 4mm were passively placed in the correspondent teeth. All samples were stored in saline solution for 7 days at 37°C before evaluation. Samples were mounted in cylindrical sample-holders using epoxy resin. Microleakage was evaluated with an automatic permeability detector that calculates nitrogen diffusion between the material-root interphase. After microleakage evaluation, the samples were recovered and analyzed by scanning electron microscopy (SEM). Microleakage results were analyzed using Chi-square and adaptation was evaluated with a descriptive analysis. Results: None of the evaluated materials completely avoided the nitrogen microleakage (positive leakage of 10% and 20% of samples for MTA and Biodentine™ respectively); with no statistical significant difference between groups (p=0.527). All apical plugs showed good adaptation under SEM, at 30x, 200x, 1000x

BRENES K., CONEJO E., VEGA J., MONTERO M., CHAVARRÍA D., 2017: Evaluation of Microleakage by Gas Permeability and Marginal Adaptation of MTA and Biodentine™ Apical Plugs: *In Vitro* Study.-ODOVTOS-Int. J. Dental Sc., 19-2 (May-August): 97-107.
ODOVTOS-Int. J. Dent. Sc. | No. 19-2: 97-107, 2017. ISSN:1659-1046. 97

"Physical and Chemical Characterization of PLA Nanofibers and PLA/ZrO2 Mesoporous Composites Synthesized by Air Jet Spinning" has been successfully submitted online and is presently being given full consideration for publication in the **Materials Research**.

Nanobots: Development and Future

Abstract

Some decades ago, nanoscale machines called "nanorobots" (better known as "nanobots") were only in science fiction. Today, they are expected to be the next generation of nanodevices and to change the technology related to medical diagnosis and drug delivery. Many challenges have to be faced to develop this technology; not only from the technical, biological and physicochemical point of view but also concerning the risks of using new materials and devices at nanoscale and their interaction with the environment and human beings. The aim of this review is to describe the nanobots, the technology and advances and in more detail the applications related to medicine.

Keywords: Nanobots; Nanomotors; Nanomedicine; Nanosensors

Review Article

Volume 2 Issue 5 - 2017

Bárbara Gutierrez[1,2], Carlos Villalobos Bermúdez[1,3], Yendry Regina Corrales Ureña[1], Stephanie Vargas Chacón[1] and José Roberto Vega Baudrit[1,2]*

[1]National Laboratory of Nanotechnology LANOTEC, Costa Rica
[2]National University of Costa Rica UNA, Costa Rica
[3]Invenio University, Costa Rica

*Corresponding author: José Roberto Vega Baudrit, National Laboratory of Nanotechnology LANOTEC, LANOTEC- CENAT-CONARE, San José, Costa Rica, Email: jvegab@gmail.com

Received: December 21, 2016 | Published: May 23, 2017

Abbreviations: NEMS: Nano Electro Mechanical System; AFM: Atomic Force Microscopy; CPE: Carbon Paste Electrodes; ATPase: Adenosine Triphosphate Synthase; AFP: Alpha-Fetoprotein; CEA: Carcinoembryonic Antigen

Introduction

The first scientist to mention the term "nanobots" was the physicist Richard Feyman in 1959; when he gave his popular talk named "There's Plenty of Room at the Bottom. He commented about nanodips and nanobots for curing heart diseases [1,2]. Later, the scientist Eric Drexler, inspired by the talk, published his book "Engines of Creation", where genetically programmed molecular machines were mentioned as upcoming technologies in cellular biology [3]. The first study related to nanobots was made by Robert Freitas [4]. It was related to medical nanobots called respirocytes; resembling red blood cells [4]. Nanobots could be defined as a controllable nanoscale machine composed of a sensor and a motor, capable by performing specific tasks [5]. These are not comparable to a drone, instead are more similar to a complex piece of fabric [6]. Robert Wood defined them as devices that detect friends or enemies; undergoing through a conformational change when they sense an enemy, catalyzing the release of a substance that can act against it [6].

Nanobots properties

Nanobots can be produced using organic materials such as proteins and polynucleotides, or inorganic materials such as metals or diamond [1,7]. In the case of diamond, this stands out for its high strength and high performance. Metals could have double purposes, for example silver. It can be the base of a nanobot and to have an antibacterial effect [8-10]. In some cases, they can act as a virus causing irreversible cell damage [5]. The surface properties of the nanobots are a key factor to define the solubility and interactions with other macromolecules or cell surfaces. Size or shape of a nanobot will affect directly their motion, permeabilization and reactivity [11]. Different extracellular nanostructures could be used as model. Ga et al. [12] used spiral water conduction vessels of plants coated with thin Ti and Ni layers, achieving efficient propulsion in biological media [12]. Depending on the fuel used, the propulsion mechanism can be biocompatible or not [13,14]. Further information about propulsion mechanisms will be presented in section 4.1.

Parts

One of the main interests for the research of nanobots in medicine has been to develop treatments targeting the exact point where it is needed, with the idea of minimizing the impact on healthy parts of the body that any regular treatment has [15]. This idea suggests having nanobots designed to detect and mobilize to a determined part of the body where the problem is located and, in the best scenario, send feedback. Because of these determinant tasks (detect and mobilize), two devices can be identified as essential: sensors and propulsion equipment; and from this information it can be deduced some other devices will be needed as well, like power supplies and molecular computers, without excluding devices to develop a specific task like storage compartments or manipulators [2].

Sensors

Sensors are one of the most important parts in nanobots. Mechanical, thermal, optical, magnetic, chemical and biological sensors have been tested in nanobots applications [14]. Any sensor that uses a nanoscale phenomenon for its operation is classified as a nanosensor [14]. On the organic part, biosensors utilize biological reactions for detecting target analytes [16], and considering the need to accomplish the target treatments goals of nanobots in medicine, this type of sensors are the most evident devices to explore in the field of nanorobotics. A clear example of this type of sensors is the utilization of nano cantilevers as a Nano Electro Mechanical System (NEMS). This system utilizes biological material that will be attached by itself to a coated cantilever, causing fundamental changes in mass or its surface tension [17].

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 8, Issue, 2, pp. 15478-15486, February, 2017

International Journal of Recent Scientific Research

ISSN: 0976-3031

Research Article

GOLD, SILVER, COPPER AND SILICONE HYBRID NANOSTRUCTURE CYTOTOXICITY

***Solano-Umaña, Victor[1] and Vega-Baudrit, José Roberto[2]**

[1]Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science PhD student DOCINADE- Costa Rica
[2]National Nanotechnology Laboratory (LANOTEC-CeNAT-CONARE), San José, Costa Rica

ARTICLE INFO

Article History:

Received 05th November, 2016
Received in revised form 08th December, 2016
Accepted 10th January, 2017
Published online 28st February, 2017

Key Words:

Porous silicone, gold nanoparticles, silver nanoparticles, copper nanoparticles, cytotoxicity.

ABSTRACT

Porous materials and nanoparticles are now day on the scope of many researches that study different application in all science areas, and the medical field is impacted by this technology. Applications like drug release, sensors, cancer treatments, tissue engineering, implants, etc. On this development the silicone or polydimethylsiloxane (PDMS) play a key role, this polymer is frequently used for medical applications as cardiac pacemakers, mammary prostheses, implants, heart valves, etc.
Porous silicone materials with immobilize nanoparticles can resolve some limitations from the non-porous silicone. At leaching method with sieve sugar was used to prepare a porous silicone with a controlled pore size distribution and mean pore size of 160 micro meters. Later this material was used to immobilized gold, silver and copper nanoparticles, cytotoxic study with MTT assay was running through ISO/EN 10993-5 and ISO/EN 10993-12, and the study non evidence statistical cytotoxicity differences between pure porous silicone matrix and porous silicone matrix with silver, gold nanoparticles or their combination, but copper nanoparticles immobilized over the silicon porous matrix evidence statistical difference on cytotoxic effect over the same cells (L929 fibroblast).

Copyright © Solano-Umaña, Victor and Vega-Baudrit, José Roberto, 2017, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Tissue engineering and human implants technology are a medical field that change every year, the nanomedicine combines different engineering techniques and science, like medicine, material engineering, biology, physics, chemist and others expertise to continue with the develop of new materials that could be addressed all requirement from our body.

This medical field associated with repairing or replacing parts or the whole damaged tissues such as bones, cartilages, blood vessels, and bladder utilizes living cells that are implanted or seeded in a scaffold to act as substrates for holding cells that will create a new tissue. To achieve tissue reconstruction as hard tissues and scaffolds, the materials must fulfill some specific requirements such as high porosity, adequate pore size, biodegradability, and biocompatibility. Therefore, scaffolds or implant materials characteristics are important for the success of the implantation process and extremely depend on the tissue to be regenerated or body place to be used for the implant. (Zandi, Mirzadeh, Mayer, Urch, Eslaminejad, Bagheri and Mivehchi, 2009).

Biocompatible implants and scaffolds allow the human body to restore the biological and mechanical functions; therefore manage to increase the quality of life. Depending on the biomedical application, the material has to withstand mechanical loads, while conducting a long term interaction with the surrounding biological tissue is promoted. Bulk material properties of the implants and scaffolds are primarily responsible for the load bearing capacities, where the interaction with the surrounding tissue is governed by the material surface (Doak, Gupta, Manivannan, Ghosh and Kahol, 2010; Feng, Gu, Yang, Hu, Lu and Huang, 2009).

The properties of porous materials, micro, meso and macroporous surfaces, based on the application and the requirement for porous size, roughness, interconnected channels, functionalized surface, to be able to induce tissue regeneration could be addressed today, and these material porous design have been combined with different properties and abilities to host (adsorption or absorption) and release specific biomolecules that promoted cell growing inside and over the porous surface (Solano-Umaña and Vega-Baudrit, 2015). Immense research during the last decade has been devoted to adjust the morphology (the size and shape) of solids at various length scales from the nanometer to the micrometer scale (Kuschel, and Polarz, 2008; Qin, Ren, Zhu, Zhang, Shang, and Wei, 2011). The porous materials research has been done with a variety of pore sizes, shapes and densities, but crucial feature is the increase in the material surface, which helps improve absorbent and adsorbent properties (Mitra, Vazquez- Vazquez,

**Corresponding author: Solano-Umaña, Victor*
Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science PhD student DOCINADE- Costa Rica

Ureña et al. Appl Adhes Sci (2017) 5:10
DOI 10.1186/s40563-017-0089-5

Applied Adhesion Science

RESEARCH Open Access

Interfactant action of an amphiphilic polymer upon directing graphene oxide layer formation on sapphire substrates

Yendry Regina Corrales Ureña[1], Welchy Leite Cavalcanti[2], Marko Soltau[3], Karolina Villalobos[1], Klaus Rischka[2], Paul-Ludwig Michael Noeske[2*], Kai Brune[2] and Stefan Dieckhoff[2]

*Correspondence: Michael.Noeske@ifam.fraunhofer.de
[2] Adhesive Bonding Technology and Surfaces, Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Wiener Straße 12, 28359 Bremen, Germany
Full list of author information is available at the end of the article

Abstract

Quality assured surface pre-treatment may greatly enhance adhesive interactions and, thus, the performance and durability of material joints. This holds true as well for substrates used in coating processes as for adherents introduced into bonding processes. Wettable polymeric wetting agents—shortly called polymeric interfactants—contribute to modifying surfaces and governing the properties of interphases. This is demonstrated for amphiphilic polymers directing the adsorption of graphene oxide (GO) nano-sheets from aqueous dispersion on alumina surfaces. In this contribution, contact angle measurements as well as X-ray photoelectron spectroscopy and scanning force microscopy investigations are applied for the characterization of thin films. GO is adsorbed either from a buffered dispersion on pristine aluminum oxide surfaces or on alumina modified with a few nanometers thin layer of a polymeric interfactant. Laterally extended nanoparticles and GO nano-sheets are preferentially found on interfactant layers whereas on pristine aluminum oxide smaller adsorbates dominate. The driving forces directing the GO attachment are discussed using a phenomenological model based on polymer/substrate interactions governing the sticking probabilities of GO nano-sheets with different sizes.

Keywords: Functional surface layers, Polymeric interfactants, Amhiphilic polymer, Graphene oxide immobilization, Aluminum oxide, Surface analysis

Background

Adhesive bonding technology and especially bonded light metal joints play an important role in vehicle and aircraft construction [1]. Among numerous approaches for the surface pretreatment of light metal adherents or substrates, layers formed by amphiphilic polymers may contribute in increasing the durability of adhesive joints or coatings [2, 3]. The adsorption behavior of amphiphilic polymers on oxide, hydroxide or carbonate-based reaction layers on the surfaces of light metal alloys recently was investigated by dissipative particle dynamics (DPD) simulations [4, 5]. The resulting some nanometers thin adsorbates were characterized by electron emission, e.g. using X-ray photoelectron spectroscopy (XPS) or optically stimulated electron emission (OSEE), by wetting techniques, and with respect to their chemical interaction with liquid water [5, 6]. Concerning the film nucleation and growth of further moieties on top of the resulting polymer-coated surfaces, the

Springer Open

© The Author(s) 2017. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

frontiers in Chemistry

REVIEW
published: 21 February 2017
doi: 10.3389/fchem.2017.00006

NIST

Silver Nanoparticles: Technological Advances, Societal Impacts, and Metrological Challenges

Bryan Calderón-Jiménez[1,2], Monique E. Johnson[1], Antonio R. Montoro Bustos[1], Karen E. Murphy[1], Michael R. Winchester[1] and José R. Vega Baudrit[3]**

[1] Material Measurement Laboratory, Chemical Sciences Division, National Institute of Standards and Technology, Gaithersburg, MD, USA, [2] Chemical Metrology Division, National Laboratory of Metrology, San Jose, Costa Rica, [3] National Laboratory of Nanotechnology, National Center of High Technology, San Jose, Costa Rica

OPEN ACCESS

Edited by:
Renato Grillo, Universidade Federal do ABC, Brazil

Reviewed by:
Bonjaram M. Reddy, CSIR—Indian Institute of Chemical Technology, India
Eric D. Van Hullebusch, UNESCO-IHE Institute for Water Education, Netherlands
Monique C. P. Mendonça, University of Campinas, Brazil

***Correspondence:**
Bryan Calderón Jiménez
bcalderon@lacomet.go.cr
José R. Vega Baudrit
jvegab@gmail.com

Specialty section:
This article was submitted to Green and Environmental Chemistry, a section of the journal Frontiers in Chemistry

Received: *21 December 2016*
Accepted: *06 February 2017*
Published: *21 February 2017*

Citation:
Calderón-Jiménez B, Johnson ME, Montoro Bustos AR, Murphy KE, Winchester MR and Vega Baudrit JR (2017) Silver Nanoparticles: Technological Advances, Societal Impacts, and Metrological Challenges. Front. Chem. 5:6. doi: 10.3389/fchem.2017.00006

Silver nanoparticles (AgNPs) show different physical and chemical properties compared to their macroscale analogs. This is primarily due to their small size and, consequently, the exceptional surface area of these materials. Presently, advances in the synthesis, stabilization, and production of AgNPs have fostered a new generation of commercial products and intensified scientific investigation within the nanotechnology field. The use of AgNPs in commercial products is increasing and impacts on the environment and human health are largely unknown. This article discusses advances in AgNP production and presents an overview of the commercial, societal, and environmental impacts of this emerging nanoparticle (NP), and nanomaterials in general. Finally, we examine the challenges associated with AgNP characterization, discuss the importance of the development of NP reference materials (RMs) and explore their role as a metrological mechanism to improve the quality and comparability of NP measurements.

Keywords: silver nanoparticles, synthesis, characterization, environment health and safety, metrology, reference materials

DEFINING NANOMATERIALS AND NANOPARTICLES: THEIR IMPORTANCE IN NANOSCIENCE, AND NANOTECHNOLOGY

Standardization of vocabulary and nomenclature used in nanotechnology and nanoscience creates a common language through which research and industrial activities can be defined. Moreover, robust and well-founded definitions of the terms in these fields are essential to the formation of legally defensible and beneficial regulations to protect the environment and human health (ISO/TS 80004-1, 2015). Currently, an internationally harmonized definition for the term "nanomaterial" has not been established (Lövestam et al., 2010). Rather, a wide range of definitions are being used by different national authorities, scientific committees, and international organizations (Lidén, 2011; Boverhof et al., 2015; Contado, 2015), a few of which are discussed in this manuscript. The International Organization for Standardization (ISO) develops voluntary, consensus-based standards through the participation of over 160 national standards bodies and has been active in the promotion of uniform terminology in the field of nanotechnology. ISO defines a nanomaterial "as a material having any external dimension in the nanoscale or having internal structure or surface structure in the nanoscale" (ISO/TS 80004-1, 2015). The term "nanoscale" is further defined by ISO as the "length range approximately from 1 to 100 nm" (ISO/TS 80004-1, 2015). ISO classifies nanomaterials in two main categories: Nano-objects and nanostructured materials. A nano-object

Volume XXX (Year) https://doi.org/10.6028/jres.XXX.XXX
Journal of Research of National Institute of Standards and Technology

NanoUV-VIS: an interactive visualization tool for monitoring the evolution of optical properties of nanoparticles throughout synthesis reactions

NIST

Bryan Calderón-Jiménez[1,2], Gabriel F. Sarmanho[1,3], Karen E. Murphy[1], Antonio R. Montoro Bustos[1] and Jose R. Vega-Baudrit[4]

[1]National Institute of Standards and Technology,
Gaithersburg, MD 20899

[2]Costa Rican Metrology Laboratory,
San Jose, 1736-11501, CR

[3]National Institute of Metrology, Quality and Technology,
Duque de Caxias, Rio de Janeiro, 2679-9001, BR

[4]National Laboratory of Nanotechnology,
San Jose, 1174-1200, CR

bryan.calderonjimenez@nist.gov / bcalderon@lacomet.go.cr
gabriel.sarmanho@nist.gov / gfsarmanho@inmetro.gov.br
antonio.montorobustos@nist.gov
karen.murphy@nist.gov
jvegab@gmail.com

Software DOI: https://doi.org/XXXXX/XXXXX

Software Version: 1.0

Key words: 2D spectrum; 3D spectrum; Full Width at Half Maximum; maximum optical absorbance; nanoparticles; Surface Plasmon Resonance Peak; Ultraviolet/Visible Spectroscopy.

Accepted: To be added by JRes

Published: To be added by JRes

https://doi.org/10.6028/jres.XXX.XXX

1. Summary

Engineered nanoparticles (NPs) are being used for a broad array of high technology applications including sensing, imaging, targeted drug delivery, bio-diagnostics, catalysis, optoelectronics and film growth seeding. [1, 2]. The enhanced optical, electrical and catalytic properties of metal NPs are strongly correlated with their size, shape, and structure [3]. As such, physicochemical characterization of NPs is critically important to ensure their effective use and applicability.

Encapsulation of Bacterial Metabolic Infiltrates Isolated from Different *Bacillus* Strains in Chitosan Nanoparticles as Potential Green Chemistry-Based Biocontrol Agents against *Radopholus similis*

Hilary Ureña-Saborío[1]*, Sergio Madrigal-Carballo[1], Jorge Sandoval[2], José R. Vega-Baudrit[3] and Alejandro Rodríguez-Morales[2]

[1]*National Center for Biotechnological Innovations (CENIBiot), CeNAT-CONARE, San José, Costa Rica*
[2]*Biocontrol Research Laboratory, National Banana Corporation (CORBANA), Guápiles, Costa Rica*
[3]*National Nanotechnology Laboratory (LANOTEC), CeNAT-CONARE, San José, Costa Rica*

Received November 01, 2016; Accepted February 13, 2017

ABSTRACT: Currently there is a trend towards reducing the use of agrochemicals in developing countries. However, they are still being applied intensively in tropical countries. Thus, there is a trend towards developing new products based on natural chemicals for pest control, leading to second-generation pesticides incorporating nano- and biotechnologies. Costa Rica is one of the largest producers of bananas in the world. One of the most important pests of banana and plantain crops is the burrowing nematode, *Radopholus similis* (Cobb) Thorne. Highly toxic chemical compounds have traditionally been used to control this specific pest in banana plants, which can have dangerous effects on the environment and living beings as well. Biological control agents (BCA) like *Bacillus* isolated from nematode suppressive soils, in combination with nano- and biotechnological approaches, are gaining attention in the National Banana Corporation (CORBANA), as this plague generates great economic losses for the country. In order to perform encapsulation of active banana nematode biocontrol agents, we have been applying biopolymer carrier agents, such as chitosan and alginate, due to their recognized biocompatibility, biodegradability and low toxicity. Therefore, we have developed innovative formulations based on green chemistry approaches for encapsulating bacterial metabolic infiltrates (BMI) from four different *Bacillus* strains in order to improve the persistence and spread of these biocontrol agents in the soil and, consequently, becoming an effective pest control for banana plantations.

KEYWORDS: Banana, *Radopholus similis*, bacterial metabolic infiltrates, chitosan

1 INTRODUCTION

Green chemistry is a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products. Green chemistry moves products and processes toward an innovative economy based on protecting and improving soil quality, reducing dependence on nonrenewable resources, such as fuel, synthetic fertilizers and pesticides, and minimizing adverse impacts on safety, wildlife, water quality, and other environmental resources.

Reduction in the use of agrochemicals in developing countries is becoming a trend due to the intensive application of pesticides and environmental pollutants over the years. Different studies have concluded that no more than 0.1% of the agrochemicals applied in the fields can successfully reach the plague they are designed to control; meanwhile, the rest of the product circulates in the environment, polluting the surrounding soil, water and biota [1]. Thus, new trends in agrochemical design are now looking for biocontrol compounds with greater efficiency and less pollution, using natural and biological compounds for pest control [2]. These innovative biocontrol agents (BCA) are based on combined formulations, incorporating key agents to stabilize, protect and activate the natural or biological compounds in the product [3]. Developing of novel agricultural BCA products may involve

*Corresponding author: hilarydic93@hotmail.com

DOI: 10.7569/JRM.2017.634119

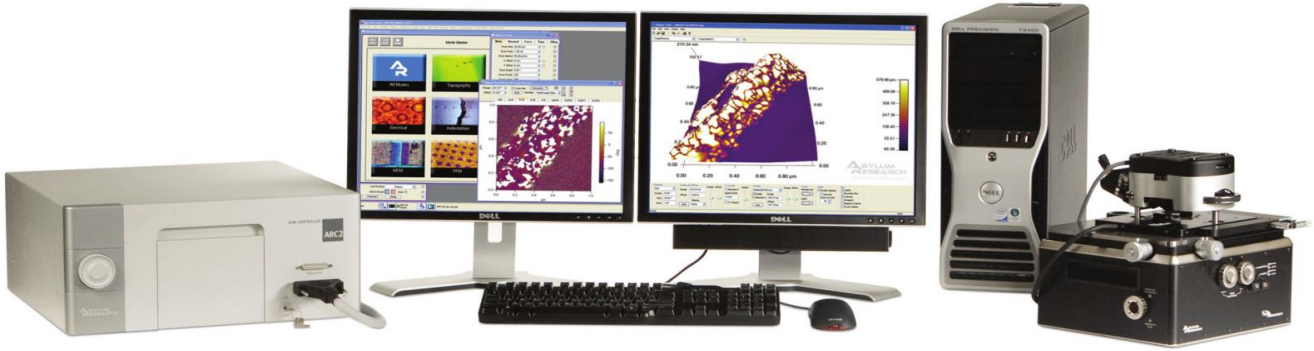
© 2017 Scrivener Publishing LLC

Contra nematodos: bacilos en quitosano

Exposición de los resultados en la prensa nacional

Laboratorio de EQUIPOS:

Atomic force microscopy **AFM**



Análisis de Alta Resolución de Cromosomas Humanos con Microscopía de Fuerza Atómica en Costa Rica

Giovanni Sáenz-Arce, Orlando Argüello-Miranda

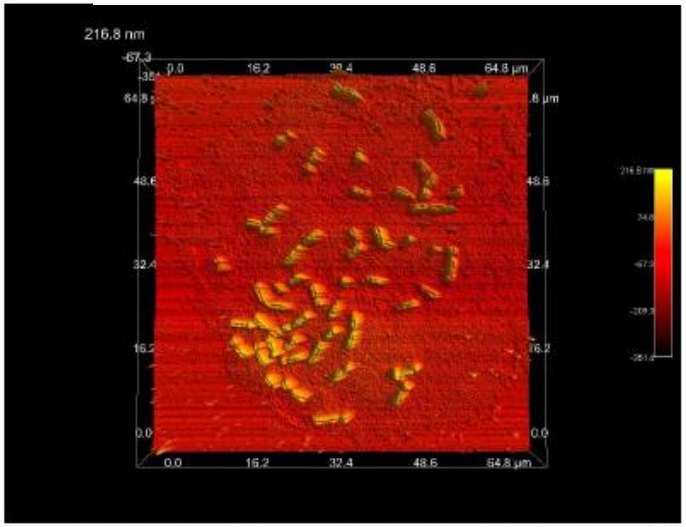


Figura 2: Imagen tridimensional de una preparación metafásica de sangre periferica.

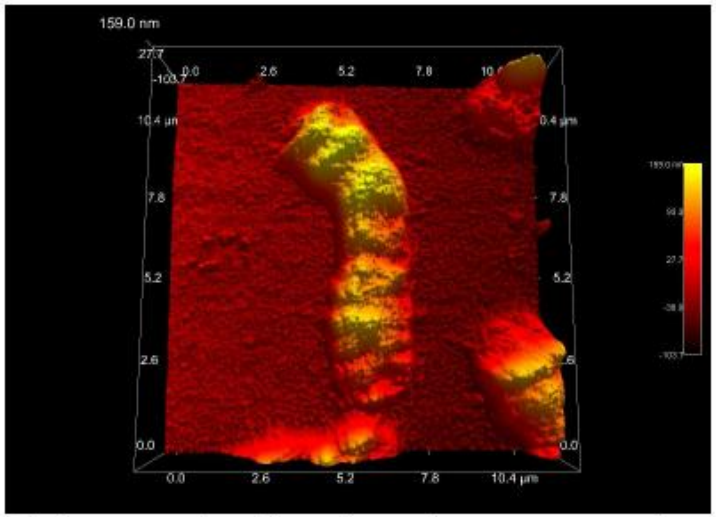
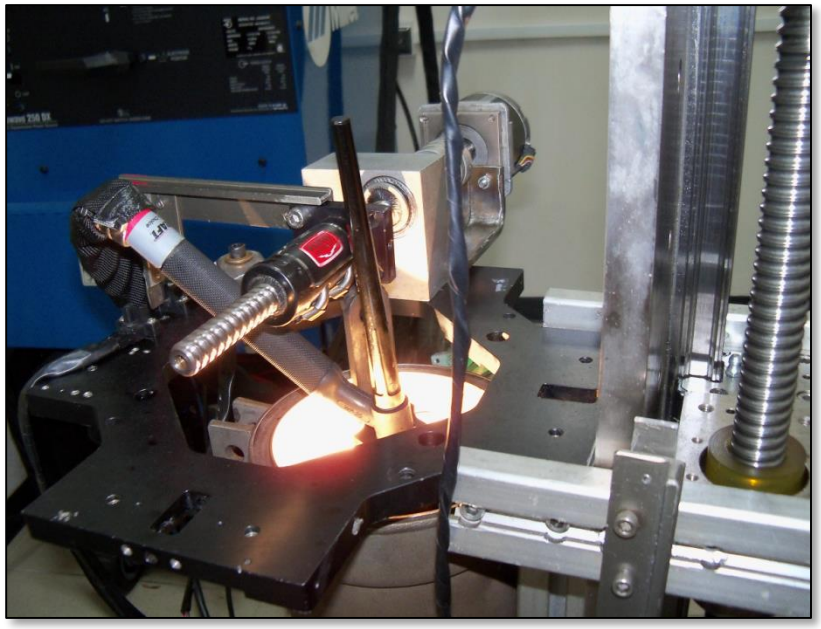


Figura 3: Imagen en tres dimensiones de un cromosoma bandeado.



NTC de pared simple

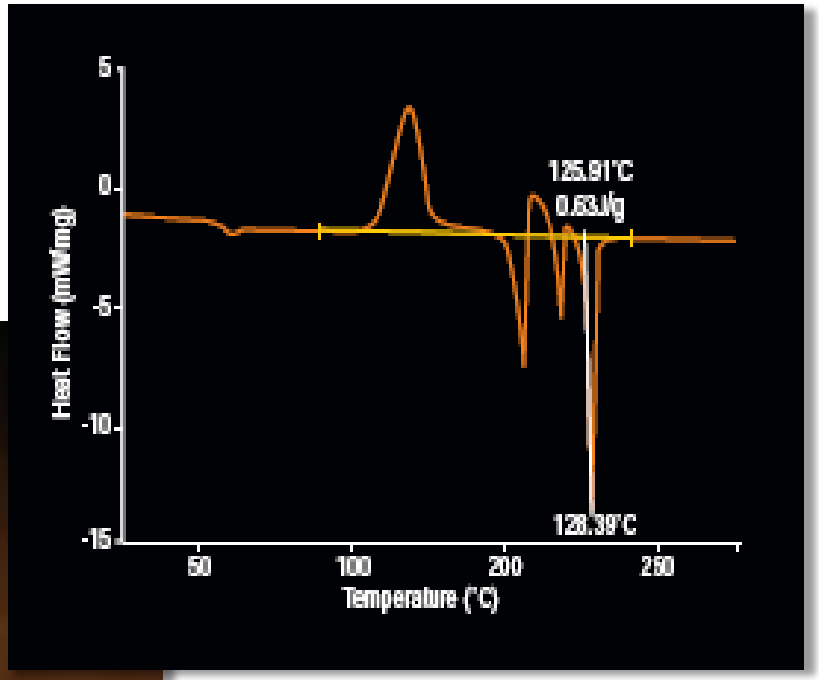
Single-walled CNT`s

SWCNT

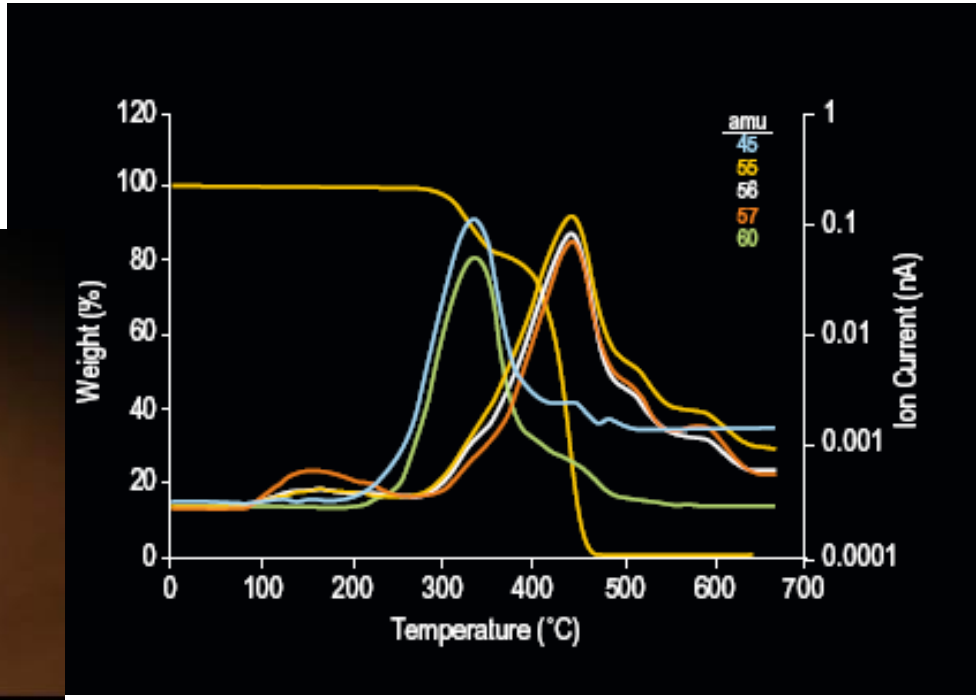
United States patent No.
US6,740,224 B1
From may, 2004

Inventors: Jeanette Benavides,
Henning Leidecker
Jeffrey Frazier
Estudiantes secundaria

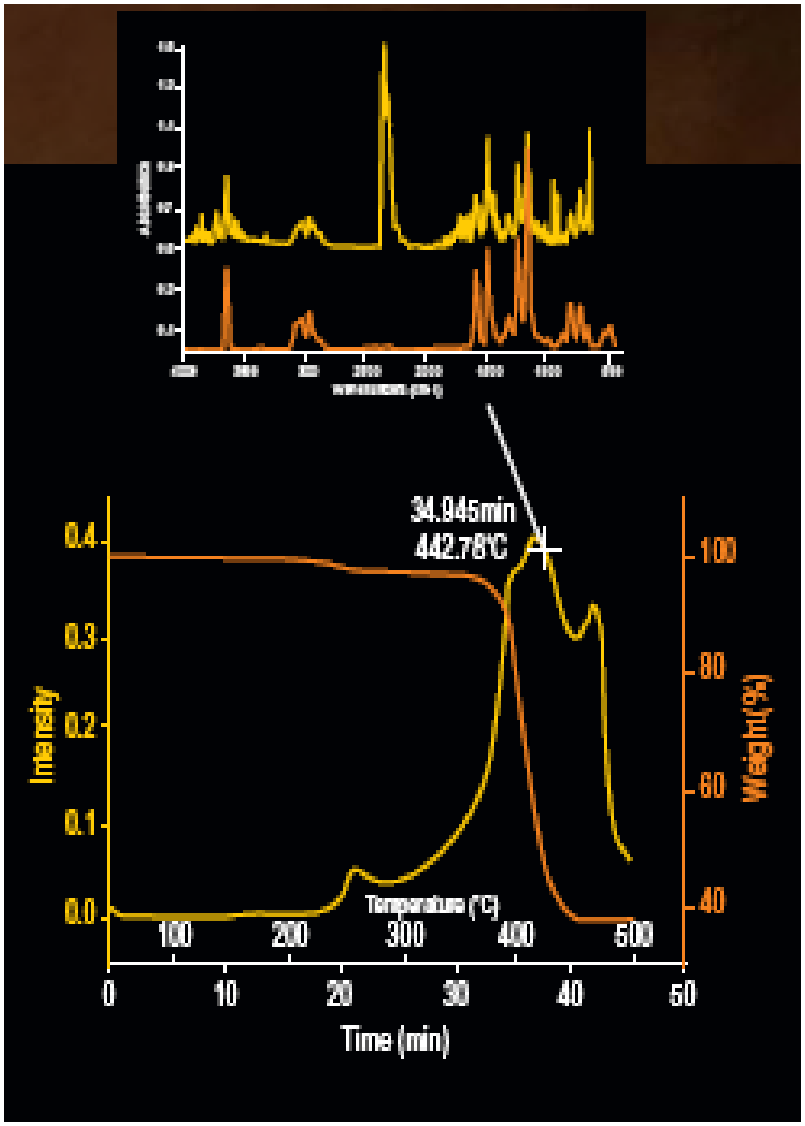
Calorimetría diferencial de barrido DSC.



Equipo de análisis termogravimétrico TGA



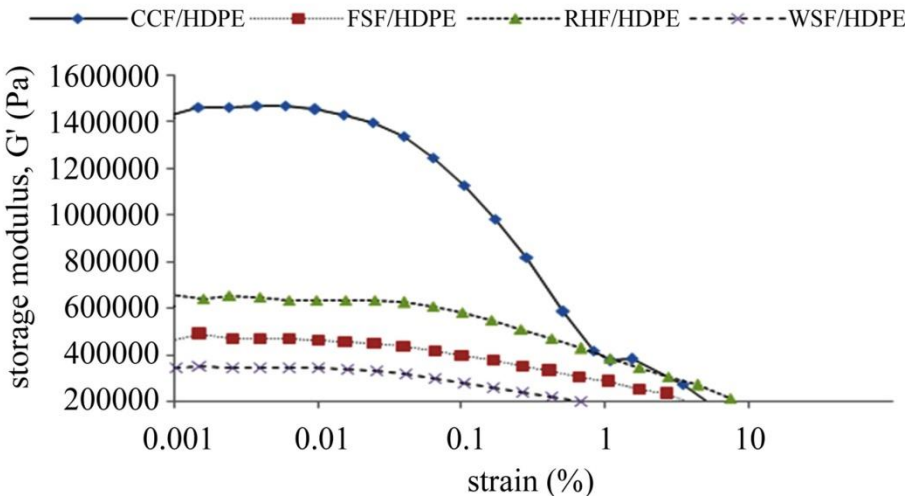
TGA-DTGA acoplado a FTIR ATR



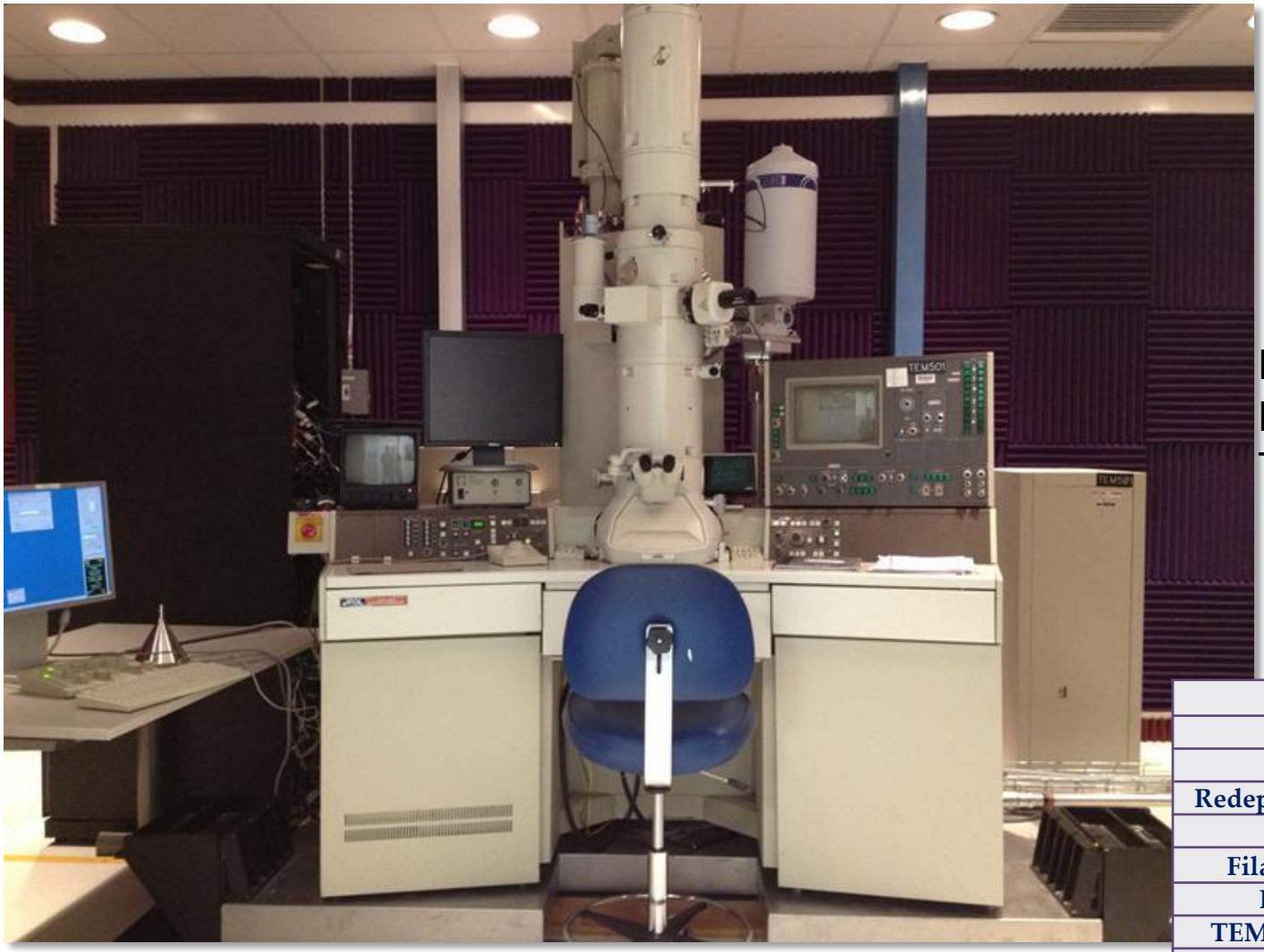
Nanocalorímetro ITC

Entalpía min: 0.1 uJ

DH3 Reómetro -DMTA



Propiedades reológicas:
Viscosidades
Tg, módulos de almacenamiento, de Pérdida, tan delta, entre otros.



TEM

MICROSCOPIO ELECTRONICO DE TRANSMISION

Brand	**JEOL**
Model	**JEM2010**
SN	**EM 137150-100**
Redeployment Site	**New Mexico**
Owner	**Rulio Guerrero**
Filament type	**LaB_6**
HT (kV)	**200**
TEM Resolution	**1.9 Å**
STEM resolution	**Not Available**
CCD camera	**Yes**
Brand	**GATAN**
Model	**794**
EDS system	**Yes**
Brand	**OXFORD**
Model	**INCA**

Capabilities:

1.	TEM Mode:	Bright Field, Dark Field	Available
2.	SA:	Selective Area (Diffraction Pattern)	Available
3.	STEM Mode:	Bright Field and Dark Field	NOT AVAILABLE
4.	EDS:	OXFORD (INCA)	Available
5.	CCD:	GATAN	Available

MICROSCOPIO ELECTRONICO DE BARRIDO

SEM JEOL jsm-6390 lv -EDS

note: photo shows nonstandard options

Otros equipos:

Goniómetro

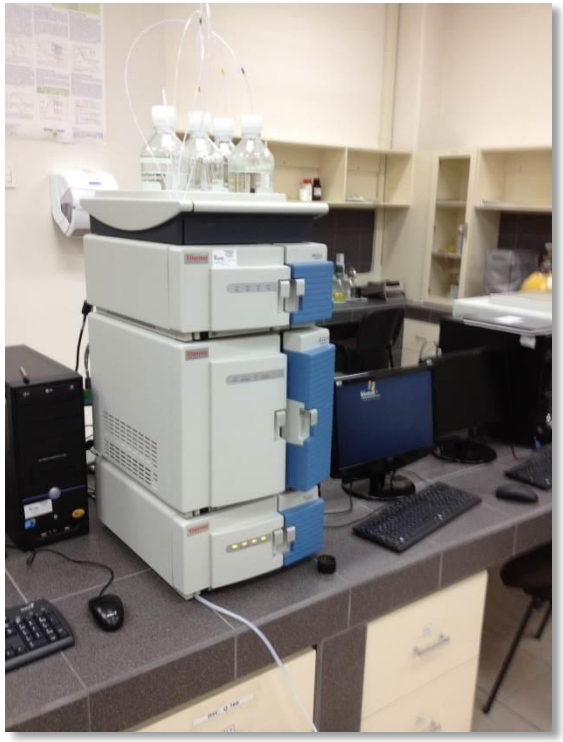
FTIR de transmisión

Secuenciador DNA

Microscopios para muestras biológicas y materiales con luz polarizada

Tensiómetro

HPLC-GPC-
Índice de refracción
y arreglo de diodos



GC-FID

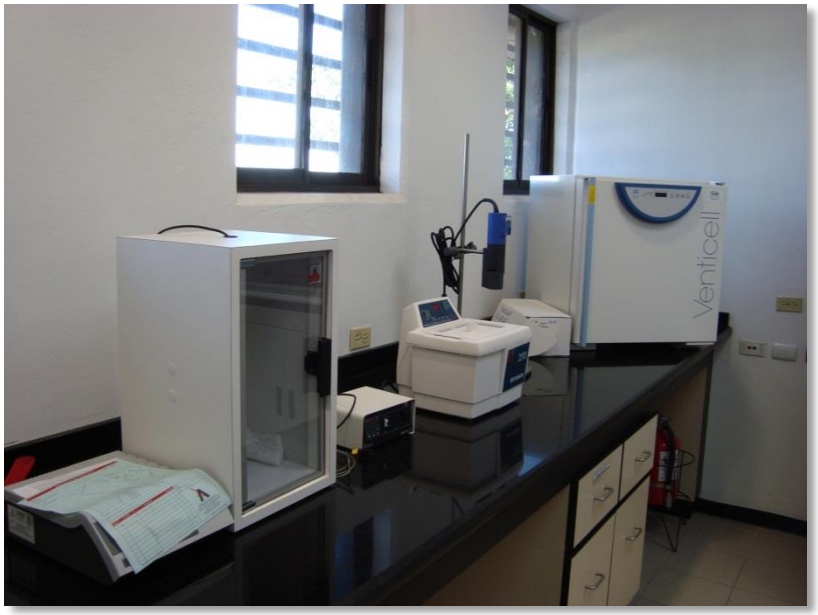
Karl Fischer

Viscosímetro
de Brookfield

3.3. Laboratorio de PREPARACIÓN de muestras:

Milli-Q

Venticell

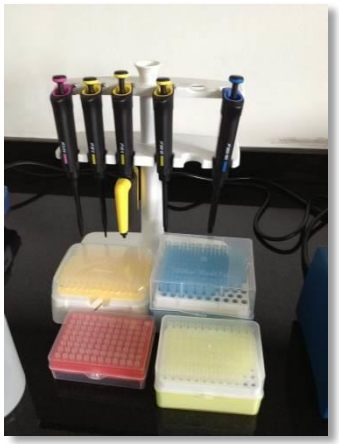

Venticell

LANOTEC

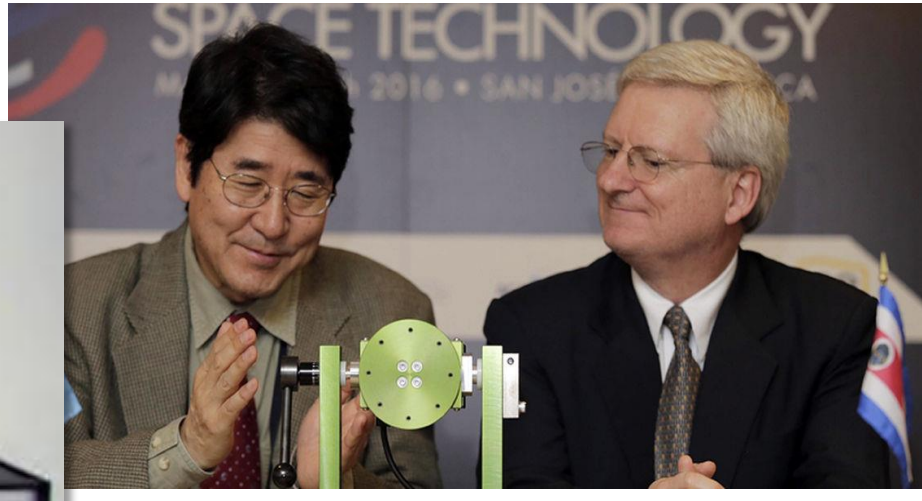
LABORATORIO NACIONAL DE NANOTECNOLOGIA

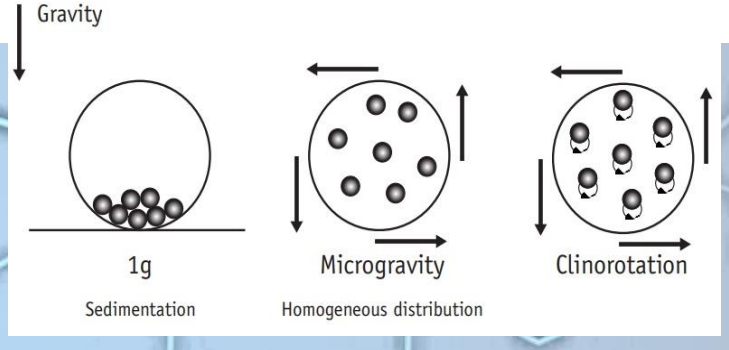
Otros equipos:

Rotavapor,
Ultrasonido,
Mili-q,
Sonicator,
Capilla,
pH-metro,
Encubadora,
Cámara de flujo laminar,
Ultramezcladora,
Autoclaves,
Centrífuga,
Vortex,
Balanza de humedad
Balanza analítica



CLINOSTAT


SPACE TECHNOLOGY


Gravity
1g
Sedimentation
Microgravity
Homogeneous distribution
Clinorotation

Microgravity and nanotechnology

Melissa Palma Jiménez[1], Yendy Corrales Ureña[1], Carlos Villalobos Bermúdez[1], José Roberto Vega Baudrit[1*].
National Laboratory of Nanotechnology[1]. Corresponding author: jvegab@gmail.com

Abstract: Some experiments evidence that microgravity has influence in the morphology growth rate of materials and physiology of biological systems. Some microgravity systems have been developed for experimentation under these conditions. The 2-D, 3-D clinostats and Random Positioning machines stimulate weightlessness. The aim of this review is to show the state of the art of the research related to the effect of microgravity on organic and inorganic materials, and to describe the physiological effect, and the biological response to understand their behavior in simulated microgravity. Some examples related to nanoparticle growth, the effect on cell pants as corn (*Zea mays*) and rice (*Oryza sativa*), and bean (*Phaseolus vulgaris*) will be shown, and the effect of microgravity on osseous and muscular tissue.

Key words: Crystallization, organic and inorganic materials, biological response, 2D-clinostat.

1. PROYECTO MARTE
2. VOCACIONES CIENTIFICAS.

Viernes, 5 de Mayo de 2017 | 1:56 pm

Tica lidera pruebas en desierto de Utah

Donde se simula una exploración aeroespacial en Marte

facebook Twitter Google + Comentar

A partir de esta semana Yendry Corrales Ureña, una de las investigadoras del centro nacional de alta tecnología, inició la misión Latam 1, que simulará una exploración aeroespacial en marte, en la estación de investigación desértica en Utah, estados unidos.

Utiliza trajes, tanques de oxígeno, alimentación espacial y maquinaria como si en realidad estuvieran en una exploración científica en Marte.

Temas relacionados: NC Once noche

PROYECTO MARTE

Misión hará exploraciones aeroespaciales en Utah, Estados Unidos

CIENTÍFICA TICA ESTARÁ EN ESTACIÓN SIMULADA DE MARTE

Yendry Corrales Ureña investiga el crecimiento de plantas en microgravedad para determinar cómo se desarrollan y qué cambios se generan. Emplea un equipo denominado Clinostat.

KRISSIA MORRIS GRAY
kmorris@diarioextra.com
Fotos: Carlos Barquero

Debido a su interés en cuanto a la reacción y comportamiento de las cosas en pequeños tamaños en la microgravedad a nivel espacial, la científica Yendry Corrales Ureña, investigadora del Laboratorio de Nanotecnología (Lanotec) del Centro Nacional de Alta Tecnología, del Consejo Nacional de Rectores (CeNat-Conare), integrará una misión que simulará una exploración aeroespacial en Marte.

La exploración simulada de Marte se llevará a cabo en la Estación de Investigación Desértica Marciana, ubicada en el desierto de Hanksville, Utah, Estados Unidos, de la asociación Mars Society.

La misión es meramente latinoamericana y es conocida como Latam 1. Estará conformada por 7 personas, de las cuales la tica será la única mujer y se ubicará entre quien lidere o la segunda a cargo de la investigación, debido a su experiencia profesional pues es doctora en Ciencias Naturales en Nanotecnología.

"En las misiones hay posiciones, por la experiencia profesional que tengo me pusieron en una posición en la cual podría ser una de las que dirija a los otros chicos en la parte de investigación y de ejemplo en la misión", mencionó.

Corrales fue escogida tras un proceso de selección y exposición de proyectos realizados por científicos de diferentes países de Latinoamérica a la Mars Society, notificación que le llegó en diciembre anterior.

Participarán científicos de Perú, México, Argentina, Colombia y Costa Rica.

¿En qué consiste el proyecto?

Explicó que el desierto de Utah presenta las condiciones para el proyecto, según lo que se sabe del Planeta Rojo, por lo que la misión se mantendrá en el lugar desde el 29 de abril al 15 de mayo; se pondrán trajes, tanques de oxígeno, tendrán alimentación espacial y maquinaria como si en realidad estuvieran en una exploración científica en Marte.

Sobre el proyecto comentó que se relaciona con ensamblaje de nanoestructuras en condiciones espaciales y para ello el Lanotec cuenta con equipo generador de microgravedad llamado Clinostat, con el cual se comenzó a indagar el comportamiento de los materiales en gravedad.

"La parte aeroespacial se ha enfocado solo en lo que es comportamiento de células, de plantas, y ya cosas más macro, por lo que hay muy poca información relacionada a lo que es la nanotecnología, es decir, el comportamiento de los materiales a una escala más pequeña", explicó Corrales.

Uno de los materiales con el cual se trabajará es el hierro, debido a que tiene un uso muy extensivo en diversas áreas, como es el caso de la imagenología clínica.

"Lo que se busca es usar un material o materia prima que ya se encuentra en Marte como es el hierro y, por ejemplo, si en un futuro yo quiero crear cosas allá, ya tener esa experiencia previa, porque ese material ya está allá".

Enfatizó el objetivo es que se cuente con información previa o base y materia prima sobre las condiciones espaciales de los elementos a nivel de nanotecnología, para que sea usada en caso de que se concrete algún proyecto real en Marte.

Agregó que el desierto de Utah cuenta con una composición muy similar que se tiene en Marte desde el punto de vista geológico.

"Por ejemplo, hay muchos óxidos de hierro en el suelo del desierto como lo que hay en Marte. La idea es aprovechar la composición química del suelo del desierto y extraer diferentes compuestos para formar y tratar de sintetizar diferentes estructuras y ver cómo se comportan.

Además se busca usar microgravedad y usar los cambios de temperaturas, pues en Marte hace mucho frío y la temperatura sube y baja al igual que en el desierto, por eso se escoge ese desierto para poner allí la base. La idea es aprovechar las condiciones del desierto, llevar equipo de microgravedad para ensamblar o sintetizar estructuras y ver cómo se comportan", detalló.

La experta sostuvo que las propiedades de los materiales cambian en los procesos de ensamblaje de estructuras desde el punto de vista catalítico, así como la naturaleza alrededor.

Sostuvo que se busca generar conocimiento exclusivo para en un futuro trasladarlo a las misiones aeroespaciales reales.

¿QUIÉN ES?

- **Nombre: Yendry Corrales Ureña.**
- **Vecina de: Aserrí.**
- **Hizo la primaria en la Escuela Manuel Hidalgo Mora.**
- **Sacó la secundaria en el Liceo de Aserrí.**
- **Cursó Ingeniería Química en la Universidad de Costa Rica (UCR).**
- **Es doctora en Ciencias Naturales en Nanotecnología.**
- **6 años de ser investigadora.**
- **Labora en el Lanotec.**

¿QUÉ ES LA MARS SOCIETY?

La Mars Society es una organización internacional sin fines de lucro dedicada a promover la exploración y colonización de Marte. Fue creada en 1998 por Robert Zubrin y ha recibido el apoyo de escritores y directores de ciencia ficción, entre los que se encuentran Kim Stanley Robinson o James Cameron; así como a científicos astrónomos, astrofísicos, planetólogos, biólogos, entre otros. La organización se dedica a convencer al público y a los gobiernos de los beneficios de la exploración espacial y de Marte en particular, y aboga por la idea de misiones humanas para el Planeta Rojo.

Fuente: Wikipedia

Microgravity and Nanomaterials

Melissa Palma-Jiménez[1*], Yendry Corrales Ureña[2], Carlos Villalobos Bermúdez[3], José Roberto Vega Baudrit[4*]

[1]National Laboratory of Nanotechnology, Area of Nanobiotechnology, Costa Rica. *Corresponding author: melissapal@gmail.com.
[2]National Laboratory of Nanotechnology, Area of Nanotechnology, Costa Rica. E-mail: yendry.corrales.urena@gmail.com.
[3]National Laboratory of Nanotechnology, Area of Mechatronics, Costa Rica. E-mail: carlosml.villalobos@gmail.com.
[4]National Laboratory of Nanotechnology, Area of Nanotechnology and Polymers, Costa Rica. *Corresponding author: jvegab@gmail.com. [1-4]Postal address: 1174-1200.

Running title: Microgravity and Nanomaterials

Abstract Some experiments evidence that Microgravity (Micro-g) has influence in the morphology growth rate of materials and physiology of biological systems. Some Micro-g systems have been developed for experimentation under these conditions. The 2-D, 3-D clinostats and Random Positioning machines stimulate weightlessness. The aim of this review is to show the state of the art of the research related to Micro-g effect on inorganic and organic materials. Some noticeable examples related to changes in nanomaterial morphology; physiological effect, and cellular response in biological systems of plants cells as maize (*Zea mays*), rice (*Oryza sativa*) and bean (*Phaseolus vulgaris*); and osseous and muscular tissue will be shown. There has been identified the Micro-g as a new condition of significant structural and functional changes in the organization cellular.

Key words Organic and inorganic materials, Biological response, Morphology, Crystallization, 2-D clinostat.

1. Introduction

Recent advances in aerospace science have made it possible investigate the effect of Microgravity (Micro-g) within the confines of an earthbound laboratory [1, 2, 3]. Some experiments have evidenced that Micro-g alters the organization of inorganic materials as crystals [4] and mineralized structures [5]. Also, the morphology and physiology of biological systems; differentiation, proliferation, metabolism, and size are some of the cellular properties affected [6, 7, 8].

The term Micro-g is frequently used as a synonym of weightlessness and zero-g, which indicates that the g-forces are not actually zero but just very small. Several experiments have been performed in Space or on Earth with simulators of Micro-g [9]. According to Eiermann et al. [10] experimental capacities in real Micro-g are limited due to high cost and due to the experimental time. Therefore, parabolic flights (with repetitive changes of Micro-g and hypergravity phases) or ground-based facilities (aiming to achieve conditions of simulated Micro-g) are often used to investigate samples under altered gravity conditions, which in turn provide a prerequisite for experiments intended to be flown in space.

Experiments in Earth have made it possible to understand this phenomenon [4, 11]. Two and three-dimensional clinostat (2-D and 3-D respectively) and Random Positioning Machine (RPM) are tool used to simulate weightlessness [12]. Herranz et al. [9] explain that those tools are valuable for preparing spaceflight experiments, but they also facilitate stand-alone studies and thus provide additional and cost-efficient platforms for gravitational research. Fast-rotating 2-D clinostat is commonly used ground based facilities for exposition of inorganic and biological samples to simulated Micro-g conditions. This clinostat is able to generate high quality of reduced gravity conditions (≥0.001 g) and several studies have shown that results from various model systems using 2-D clinorotation are similar to results found in real Micro-g [10, 13, 14, 15].

In the preparation for missions to Mars, basic knowledge of the mechanisms of growth and development of biological systems under Micro-g conditions is essential. Many studies have focused on the gravity effects on cell rigidity, including mechanisms of signal perception, transduction, and response in gravity resistance. These components of gravity resistance are related to the evolution and acquisition of responses to various mechanical stresses [16].

The aim of the present review was to study the Micro-g effect on inorganic and organic materials; nanomaterials, physiological effect, and biological response on cell pants as maize (*Zea mays*), rice (*Oryza sativa*) and bean (*Phaseolus vulgaris*); also on osseous and muscular tissue.

2. Micro-g Systems: Clinostat Overview

Gravity is the force of attraction between bodies. It is proportional to the mass of the objects, and inversely proportional to the square root of the distance separating those masses [17]. Just as any other planet, Earth has its own gravitational field, which applies a force described as an acceleration of 9.81 meters per second squared (expressed as 1 g as well) to every object on the surface of the planet. Micro-g is the equivalent of 1 µg ($1x10^{-6}$ g), but the word is used to describe any other acceleration corresponding to gravity bellow 1 g on Earth's surface [18].

Micro-g occurs on any free falling object. Taking advantage of this phenomenon, some Micro-g systems have been developed for experimentation under these conditions, such as drop towers or parabolic flights of aircraft [9, 17]. There is one main problem for the general research of these effects: real Micro-g condition experiments are expensive and most of them have a limited effective time. Because of these limitations, special equipment was developed to generate simulated Micro-g conditions [10].

Real Micro-g condition experiments are complex in execution, but easy to describe. A drop tower is not exactly an equipment, it is more like a complete facility composed of a long special tube or pit, and a laboratory for testing and analyzing results. Vacuum is applied to the tube, and the sample is dropped in free fall to examine the influence of Micro-g forces on it. Meanwhile, parabolic flights are composed of an aircraft performing an acrobatic maneuver, following a trajectory similar to the one a ball would describe when kicked strongly by a sportsman: a parabolic trajectory. This movement allows an environment of Micro-g for up to 25 seconds for any sample traveling inside the aircraft, which is later examined and evaluated by a group of experts [19].

2-D, 3-D clinostats and RPM are some of the equipment utilized for Micro-g simulation. A 2-D clinostat has only one axis for rotation, and must be placed perpendicular to the gravity force direction in order to cancel the influence of the planet gravitational force [9, 20]. A 3-D clinostat has two axes for rotation, which must be perpendicular to each other. If the axes of the 3-D clinostat rotate at different speeds and directions, the device is considered a RPM [21, 22] which can be used to achieve completely different results compared to a 2-D or 3-D clinostat.

A 2-D clinostat is a device able to achieve nullification of the gravity stimulus due to its rotational movement, which creates vector averaged gravity resulting on a net sum of all forces present equaling zero, but not an absence of gravity [13, 23, 24] (Figure 1). It is not a zero gravity system, but the gravitational forces are very small. In other words, the magnitude of the gravitational force of the planet cannot be changed or completely nullified, but its influence and effects can [25]. A great advantage of 2-D clinostat devices is the possibility to simulate not only a Micro-g environment, but also specific gravitational conditions (Figure 2). For example, an angle of positive 9 degrees off horizontal will produce a 0.18 g gravitational force, which is the gravity on the surface of the Moon. The same way, an angle of 17.5 degrees will generate a 0.33 g gravitational force, equivalent to Mars gravity [26]. However, it could generate centrifuge forces and particle oscillations that can be minimized using smaller reservoirs [1]. The clinostat model system (clinorotation) is an equipment that provides a vector-averaged reduction in the apparent gravity; the specimens are then forced to passively move along a circular path. In fact, it remains hitherto unknown if a specimen indeed receives functional weightlessness during clinorotation [27]. Gravity can produce effects related to displacement (motion) and/or deformation. The consequences of having weight are related to internal stress induced over an object manifested as tensile or compressive normal loads [28].

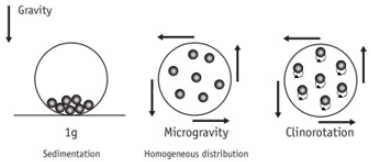


Figure 1. Representation of the rotational movement of a 2-D Clinostat. Modified from UNOOSA [18].

Research about Micro-g effects has improved our knowledge about the importance of gravitational forces on the on the materials development field, as well as biological field. In order to explore the opportunities of long term space travel, technologies for growing vegetables and harvest food in space must improve. Understanding how different plants react in a reduced or almost nullified gravity environment can help future development of those technologies. On the other hand, the production of materials could be completely different if the whole process is under the influence of Micro-g forces. Understanding if those differences are beneficial or harmful for the final results is going to be crucial in the development of procedures for material production in space [19, 29].

Figure 2. 2-D Clinostat equipment.

Docencia: 1 Nodo de desarrollo:

Ing. Andrea Rivera

Nodo	Tipología	Temas
Difusión, Educación, Enseñanza.	Programa	Jóvenes talentos, premios, publicaciones nacionales e internacionales, boletines, textos, eventos, cursos, convenios, redes, olimpiadas, PASI, ferias de ciencia y tecnología, Feria INTEL ISEF, feria ingeniería. **RED NANODYF –CYTED** Capacitaciones empresariales: Boston Sci.

- Réplica **NANOPROFESOR** en Panamá y Uruguay.
- Talleres a estudiantes de secundaria y primaria.
- Talleres de capacitación a profesores.
- Visitas guiadas al laboratorio.
- Creación de actividades para desarrollar en el aula por los profesores.
- Pasantías a estudiantes de secundaria (Premio y/o reconocimientos otorgados en actividades)
- Comité Organizador Olimpiadas Costarricense de Química: preparación de evaluaciones, preparación de estudiantes para olimpiadas internacionales.
- Otros: Material divulgativo y educativo, jueces en actividades científicas.

NANOPROFESOR: VOCACIONES CIENTÍFICAS

Estudiantes participantes

Feria de C y T

Feria Ingeniería

Olimpiadas Nacionales

Estudiantes y jóvenes rurales recomendados por tutores

Ferias internacionales

ISEF 2017

30 - 40 Estudiantes y jóvenes rurales con posible vocación
Ciencia, ingeniería, matemática

http://www3.ubu.es/ubuinvestiga/category/vocaciones-cientificas/

Innovación: proyectos PYMES, patentes y grandes empresas.

M.Sc. Melissa Camacho

PYMES Y PATENTES

NUEVA EMPRESA: Bioenergy solutions of CA S.A.

Ganancia: Creación de la planta piloto para procesos de innovación, nuevos materiales y sensores.

Reactor químico para condiciones supercríticas Biocombustibles

Energy 140 (2017) 426–435

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Castor oil (*Ricinus communis*) supercritical methanolysis

G. Torrentes-Espinoza [a], B.C. Miranda [b, *], J. Vega-Baudrit [a], Julio F. Mata-Segreda [b]

[a] Laboratorio Nacional de Nanotecnología, Centro Nacional de Alta Tecnología, Edificio Franklin Chang Díaz, Pavas, San José, Costa Rica
[b] Universidad de Costa Rica, San José, 2060 Costa Rica

ARTICLE INFO

Article history:
Received 3 April 2017
Received in revised form
16 July 2017
Accepted 31 August 2017
Available online 1 September 2017

Keywords:
Biodiesel
Castor oil
Supercritical
Transesterification

ABSTRACT

The catalyst-free transesterification of castor oil under supercritical conditions, using methanol, was studied in this research to determine the molar ratio (methanol:castor oil) and reaction time that produced the biodiesel with the highest conversion by using a 10 L stainless steel batch reactor. The experiments were carried out with 30:1, 40:1, 50:1 and 60:1 molar ratios and reaction times of 5 min, 15 min, 25 min and 35 min under the critical temperature and pressure values according to the molar ratio tested. The reaction conversion was monitored by ^{1}H NMR spectroscopy. The biodiesel was characterized in order to evaluate its accordance to the ASTM D6751 specification and to plot the thermogravimetric and calorimetric profiles of the biodiesel with the highest conversion obtained by TGA and DSC analysis. A regression model was obtained as a reference to calculate the conversion under the studied range of molar ratios and reaction times in future experiments with a coefficient of determination of 95,22% and a standard error of ±1,37% from the observed conversion.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

The growing concern for the environment and the urgent need to reduce carbon emissions to decrease its impact on the global climate have reinforced the numerous agreements and commitments among countries aimed at promoting the development of alternative renewable energy with less environmental impact [23].

Biodiesel is one of the best candidates who meet the criteria of sustainability, not only because its production has less impact on the environment, but is also biodegradable and non-toxic [20]. Biodiesel is a liquid synthetic biofuel obtained from natural lipids such as vegetable oils or animal fats, by industrial processes of esterification and transesterification, and applied in the preparation of total or partial replacement of diesel oil [9].

The main raw materials for the production of biodiesel are oilseeds and their derived oils. It can be said that the production of biodiesel comes mainly from oils extracted from traditional oilseeds, especially sunflower, soybean, rapeseed and palm. However, any matter containing triglycerides can be used for the production of biodiesel (used frying oils, chicken fat and fish fat). Climatic, geographical conditions, crop yield, oil content and the need to mechanize production currently limit profitable oilseeds to a few species. Table 1 shows the worldwide annual production of various oilseeds for the past five years.

In addition to the four highest produced oilseeds (palm, soybean, rapeseed and sunflower), there are also other edible oil plants with which it is possible to produce biodiesel such as coconut, peanut, cotton, mustard oils. However, these crops have been strongly questioned by some sectors, as they are accused of competing with food, extensive land use, and the need for irrigation, fertilization and control (herbicides and pesticides). But the main problem of these oilseeds is its price, because the cost of oil represents 75%–85% of the total price of biodiesel [43].

Opposite to conventional vegetable oils, there are other species more adapted to the conditions of the country where they develop and could be better positioned in the field of energy crops. The search for new raw materials that do not compete with the food market is a topic that arouses great interest. An ideal oilseed alternative for biodiesel production must be characterized by high climatic adaptability to the region where it is grown (rain or drought, type of soil, latitude), regional availability, high oil content, low free fatty acids, compatibility with the existing structure in the field, low agricultural needs (fertilizers, water, pesticides), seasonally defined growth, uniform maturation of the crop, potential market for byproducts and the ability to grow on undesirable land for agriculture and/or off-season of traditional crops [2].

One of the main concerns is the use of edible oils in the production of biodiesel, because it has a great influence on the global

* Corresponding author.
E-mail address: barbara.mirandamorales@ucr.ac.cr (B.C. Miranda).

http://dx.doi.org/10.1016/j.energy.2017.08.122
0360-5442/© 2017 Elsevier Ltd. All rights reserved.

OTROS PROYECTOS:

No reembolsables
PROPYMES CONICIT-MICITT

- **SENSORES: PODOMETRO (producto nuevo): 3 patentes.**
- **ANTIBIOTICO HOSPITALARIO: 1 patente.**

Finalizados 2016

- SENSORES: SILLA DE RUEDAS (mejoramiento).
- **AUMENTO DE LA EFICIENCIA DEL REACTOR SUPRECRITICO.**
- **MEJORAMIENTO DE MATERIALES: EN TABLAS DE SURF (nueva).**

En proceso

- COBERTORES EN TABLAS DE SURF.
- HONGOS COMESTIBLES (aceleración de empresa).
- DETECTORES DE DROGAS.
- BRAZO MECANICO,
- MEJORAMIENTO EN PRODUCCION DE OVEJAS.
- REFORMULACION DE KERATINA PARA CABELLO
- PROYECTO DE MASTITIS EN GANADO VACUNO.
- Nanotecnología en formulaciones de cremas y geles estéticos.
- Obtención de nuevos materiales partir de Rambután (mamón chino)
- Grafeno soluble y sus aplicaciones comerciales.
- Desarrollo de material para calzado terapéutico
- Análisis de material para desarrollo de dispositivo de retención infantil

Nuevos 2017

El desarrollo y la economía de un país está basado en las pymes !!!!!

PREMIO SAMUEL STUPP DE INNOVACION
$ 30 000.00 (50% LANOTEC)

US 20160349076A1

(19) **United States**

(12) **Patent Application Publication**

CAMPOS GALLO et al.

(10) **Pub. No.: US 2016/0349076 A1**

(43) **Pub. Date: Dec. 1, 2016**

(54) **NANOPEDOMETER**

(71) Applicant: **MULTISERVICIOS PROFESIONALES DE ESPARZA, S.A.**, Esparza, Puntarenas (CR)

(72) Inventors: **Allan CAMPOS GALLO**, Pavas, San Jose (CR); **Karen Melissa CAMACHO ELIZONDO**, Pavas, San Jose (CR); **Jose VEGA BAUDRIT**, Pavas, San Jose (CR); **David NUNEZ AGUILAR**, Esparza, Puntarenes (CR)

(73) Assignee: **MULTISERVICIOS PROFESIONALES DE ESPARZA, S.A.**, Esparza, Puntarenas (CR)

(21) Appl. No.: **14/426,243**

(22) PCT Filed: **Jan. 21, 2015**

(86) PCT No.: **PCT/CR2015/000001**

§ 371 (c)(1),
(2) Date: **Mar. 5, 2015**

Publication Classification

(51) **Int. Cl.**

G01C 22/00	(2006.01)
A43B 17/00	(2006.01)
A43B 3/00	(2006.01)
H04W 4/00	(2006.01)
G01L 1/16	(2006.01)

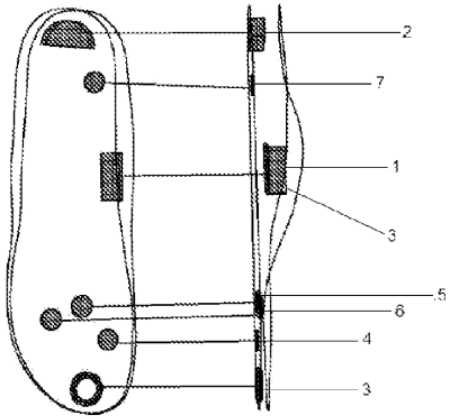
(52) **U.S. Cl.**

CPC ***G01C 22/006*** (2013.01); ***H04W 4/008*** (2013.01); ***G01L 1/16*** (2013.01); ***A43B 3/0005*** (2013.01); ***A43B 17/00*** (2013.01)

(57) **ABSTRACT**

An insole with a nanopedometer for step counting and the measurement of information parameters obtained by the same device, as well as a shoe or sneaker with said insole.

Top and side/front view



Recibido de Patentes
A&M.REF: 41 P.32

RPI-010

REGISTRO NACIONAL

REGISTRO DE LA PROPIEDAD INDUSTRIAL

SOLICITUD DE INSCRIPCIÓN DE PATENTE DE INVENCIÓN, MODELO DE UTILIDAD O DISEÑO INDUSTRIAL

Folios: 27
Copias: Si No
Certificación:
Poder: ✓ Pago: ✓
Otros:

Patente de Invención ✓	N° de Solicitud	Sello de Recibido
Diseño Industrial	USO EXCLUSIVO RPI	27 FEB. 2015 HORA: 9:12:55 FIRMA: CHS RECIBIDO
Modelo de Utilidad	Fecha de Presentación	
	USO EXCLUSIVO RPI	USO EXCLUSIVO RPI

TITULO O DENOMINACION DE LA INVENCION

NANOPODÓMETRO

DATOS DEL SOLICITANTE

Solicitante Inventor ☐ Solicitante Titular ✓

Nombre: Multiservicios Profesionales de Esparza S.A
Identificación: 3-101-433387
Nacionalidad: costarricense
Estado civil: n/a
Domicilio: San José, Santa Ana, Centro Empresarial Forum I, Edificio C, Oficina ICI

DATOS DEL INVENTOR

Nombre: Allan Campos Gallo
Nacionalidad: costarricense
Domicilio: San José, Pavas, Edificio Franklin Chang 1.3km norte de la Embajada de USA

DATOS DEL REPRESENTANTE

APODERADO ✓ GESTOR ☐

Nombre: Alejandra Castro Bonilla
Identificación: 1-0880-0193
Nacionalidad: costarricense
Domicilio: San José, Santa Ana, Centro Empresarial Forum I, Edificio C, Oficina ICI.

Lugar o medio para notificaciones: Fax N° 2204-7580 ó a la carpeta del Bufete Arias & Muñoz.

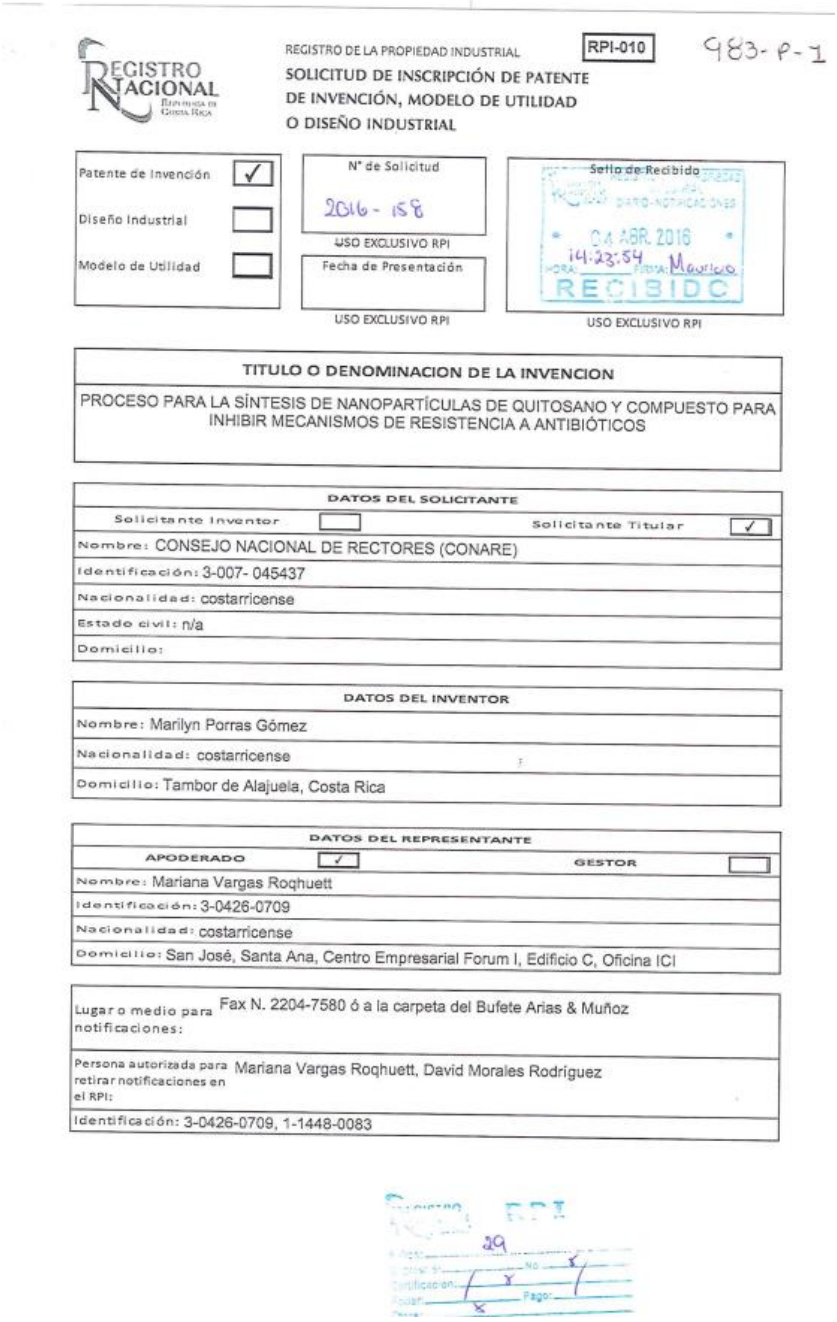
Persona autorizada para retirar notificaciones en el RPI: Alejandra Castro Bonilla, Mariana Vargas Roqhuett, David Morales Rodríguez

Identificación: 1-0880-0194, 3-0426-0709, 1-1448-0083

Proyecto podómetro: 3 patentes: PATENTE US, EUROPA, CR.

Patente

Nanoparticulas de quitosano para inhibir mecanismos de resistencia a antibióticos.



REGISTRO NACIONAL
REPÚBLICA DE COSTA RICA

REGISTRO DE LA PROPIEDAD INDUSTRIAL — RPI-010 — 983-P-1

SOLICITUD DE INSCRIPCIÓN DE PATENTE DE INVENCIÓN, MODELO DE UTILIDAD O DISEÑO INDUSTRIAL

Patente de Invención	✓
Diseño Industrial	
Modelo de Utilidad	

N° de Solicitud: 2016 - 158 (USO EXCLUSIVO RPI)

Fecha de Presentación (USO EXCLUSIVO RPI)

Sello de Recibido: 04 ABR. 2016, 14:23:54, Mauricio, RECIBIDO (USO EXCLUSIVO RPI)

TITULO O DENOMINACION DE LA INVENCION

PROCESO PARA LA SÍNTESIS DE NANOPARTÍCULAS DE QUITOSANO Y COMPUESTO PARA INHIBIR MECANISMOS DE RESISTENCIA A ANTIBIÓTICOS

DATOS DEL SOLICITANTE

Solicitante Inventor: ☐ Solicitante Titular: ✓

Nombre: CONSEJO NACIONAL DE RECTORES (CONARE)

Identificación: 3-007- 045437

Nacionalidad: costarricense

Estado civil: n/a

Domicilio:

DATOS DEL INVENTOR

Nombre: Marilyn Porras Gómez

Nacionalidad: costarricense

Domicilio: Tambor de Alajuela, Costa Rica

DATOS DEL REPRESENTANTE

APODERADO: ✓ GESTOR: ☐

Nombre: Mariana Vargas Roqhuett

Identificación: 3-0426-0709

Nacionalidad: costarricense

Domicilio: San José, Santa Ana, Centro Empresarial Forum I, Edificio C, Oficina ICI

Lugar o medio para notificaciones: Fax N. 2204-7580 ó a la carpeta del Bufete Arias & Muñoz

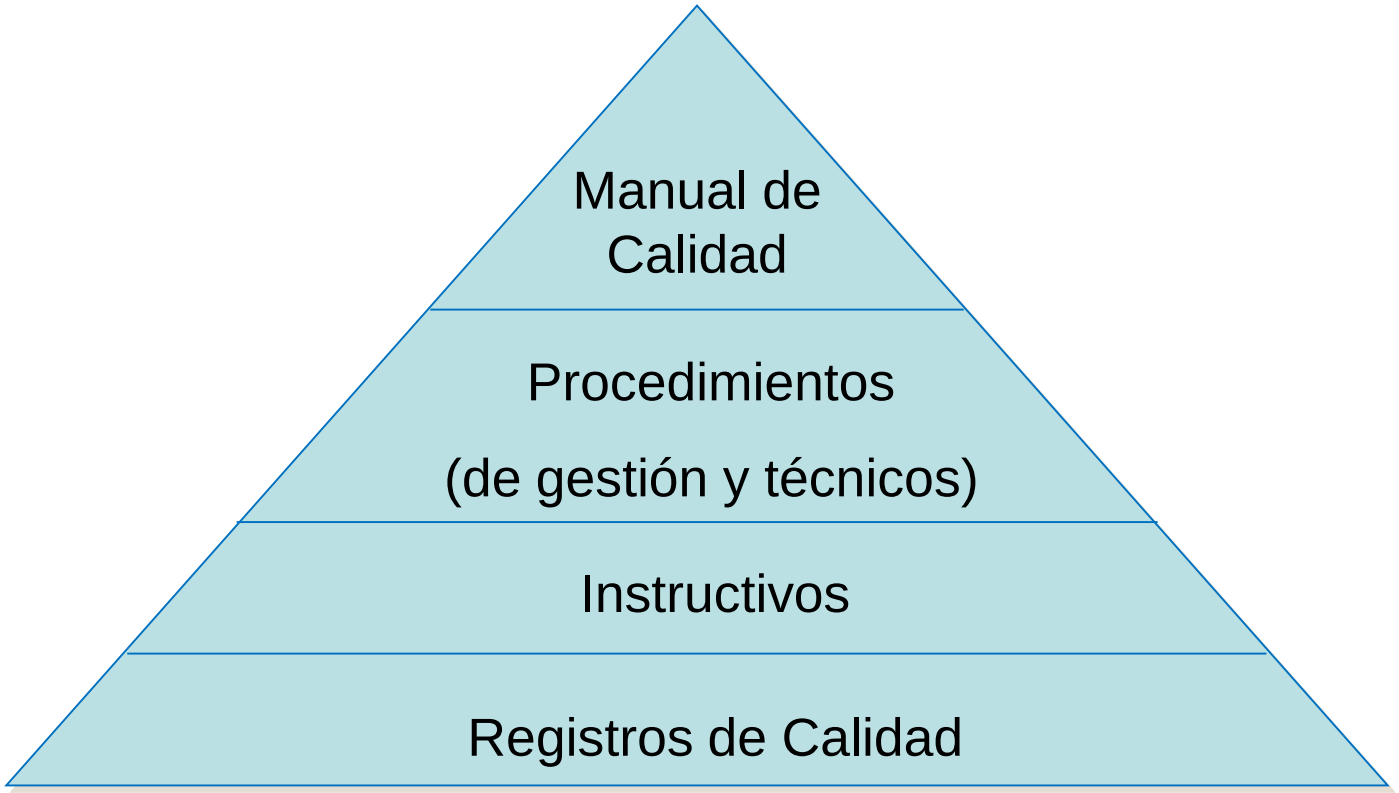
Persona autorizada para retirar notificaciones en el RPI: Mariana Vargas Roqhuett, David Morales Rodríguez

Identificación: 3-0426-0709, 1-1448-0083

29

Sistema de Gestión de Calidad

- Solicitud de las empresas del sector de dispositivos médicos.
- Certificación Norma INTE-ISO/IEC 17025:2005
- Proyecto con Procame (UNA), LETI y LANOTEC.



- **GRANDES EMPRESAS**

- EMPRESAS DE ALIMENTOS (pieles y aceites de pescado, desechos de frutas):
  - SARDIMAR, FLORIDA PRODUCTS.
- BAYER
- FIFCO: emprendimiento y Proyecto de botellas bio.
- Boston Sci: cursos alto nivel.
- EMPRESA DE MADERAS (mejoramiento de producto) BIOREFINERIA: NOVELTEAK.
- **Prestación de servicios:** Boston, Intel, Allergan, Hologic, Ad Astra, Baxter, Bayer, Pfizer, BioTD, Alunasa, Etipres.

SUBPRODUCTOS:
NANOCELULOSAS, HARINAS, DEXTRANOS, TINTES.

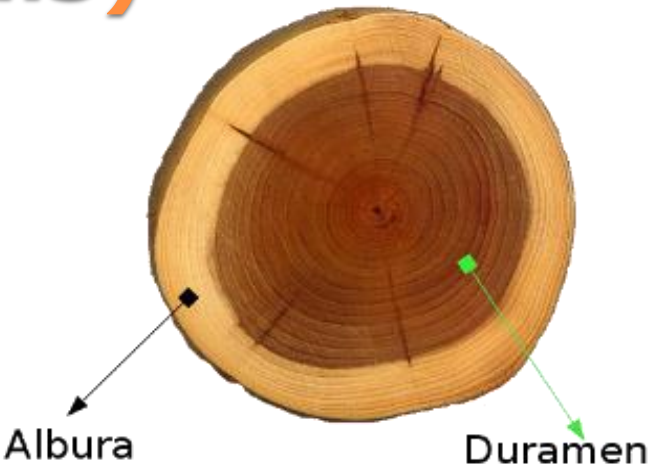
Proyecto de teca

- Proyecto con la industria Novel Teak, Costa Rica.

Contenido

1. Generalidades sobre la madera de teca.
2. Etapa 1: Homogenización del color de la teca.
3. Etapa 2: ¿Qué hacer con los residuos de teca?
   - A nivel macro
   - A nivel molecular
4. Conclusiones y recomendaciones

Generalidades sobre la teca (*Tectona grandis*)



- Madera de alto valor comercial, muy resistente.
- Dureza media.
- Coloración característica:
  - **Albura**: Café claro. Alto contenido de azúcares, poca resina y aceites. Tendencia al ataque de hongos e insectos.
  - **Duramen**: Oscuro y más resistente.
  - Más lignina, alta concentración de resinas, aceites y polifenoles (taninos).

- Lignina: 34%
- Celulosa: 46%
- Hemicelulosa: 18%
- Extractivos: 8,5-10% (duramen)

PROBLEMA DE PERCEPCION DEL MERCADO USA Y EUROPA: ALBURA IMPLICA MALA CALIDAD.

Etapa 1:
Homogenización del color de la teca

- Preparación y tamizado de las muestras
- Pruebas de caracterización de la teca (lignina, hemicelulosa, celulosa)
- Cuantificación de las sustancias extraíbles

¿Cómo se "duraminiza" la albura?

- Extractivos del duramen se agregan a la albura
  - Formulación de aditivo-colorante
  - Inmersión/impregnación de la madera
- Tratamiento térmico
  - Requiere nuevas muestras de madera para pruebas: tablillas pequeñas
  - Equipo: autoclave

Etapa 2:
¿Qué hacer con los residuos de la teca?

A nivel macro…

- Producción de tablillas de alta resistencia y propiedades mecánicas mejoradas.
- Masilla/mastique

A nivel molecular…

- Nanopartículas, gomas, adhesivos, aditivos: de los extractivos (taninos, otros fenólicos).
- Separación de lignina, celulosa:
  - **Celulosa**: Nanocelulosa, nanocristales.
  - **Lignina**: Nanopartículas, secuestradores.

Tabla comparativa de ideas propuestas

Propuesta	Valor agregado	Mercado	Costo invesión	Potenciales ganancias
Tablillas	Alto	Existente	Alto	Mediano plazo
Masilla	Bajo	Existente	Muy bajo	Corto plazo
Nanopartículas de taninos	Muy alto	Alto potencial	Mediano	Largo plazo
Formulaciones con extractivos	Medio	Existente	Bajo	Mediano plazo
Lignina y celulosa	Medio	Existente	Alto	Mediano plazo
Nanolignina, nanocelulosa	Muy alto	Alto potencial	Alto	Largo plazo
Compuestos derivados de lignina	Muy alto	Existente	Alto	Largo plazo

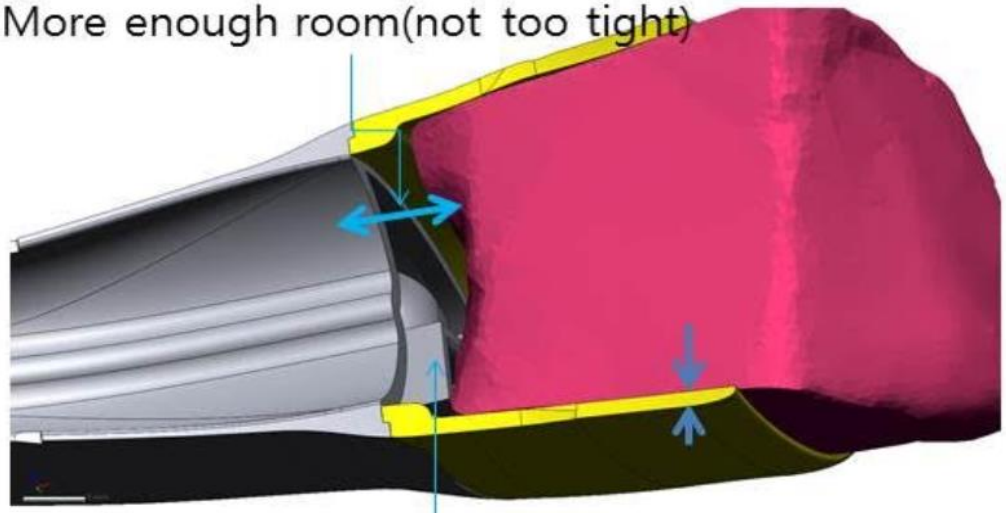
LANOTEC-POLIUNA: reconocidos como uno de los 20 Campeones de la Innovación 2013

LANOTEC: reconocidos como uno de los 20 Campeones de la Innovación 2015, SEGUNDA VEZ

EXTENSIÓN

- PROYECTO ZOOAVE “RESCATE DE GRECIA”

More enough room(not too tight)

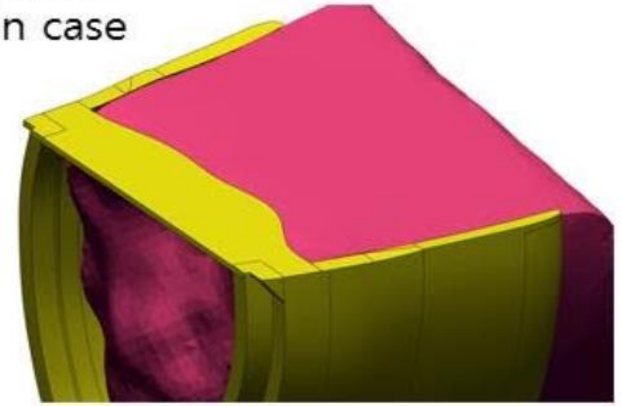


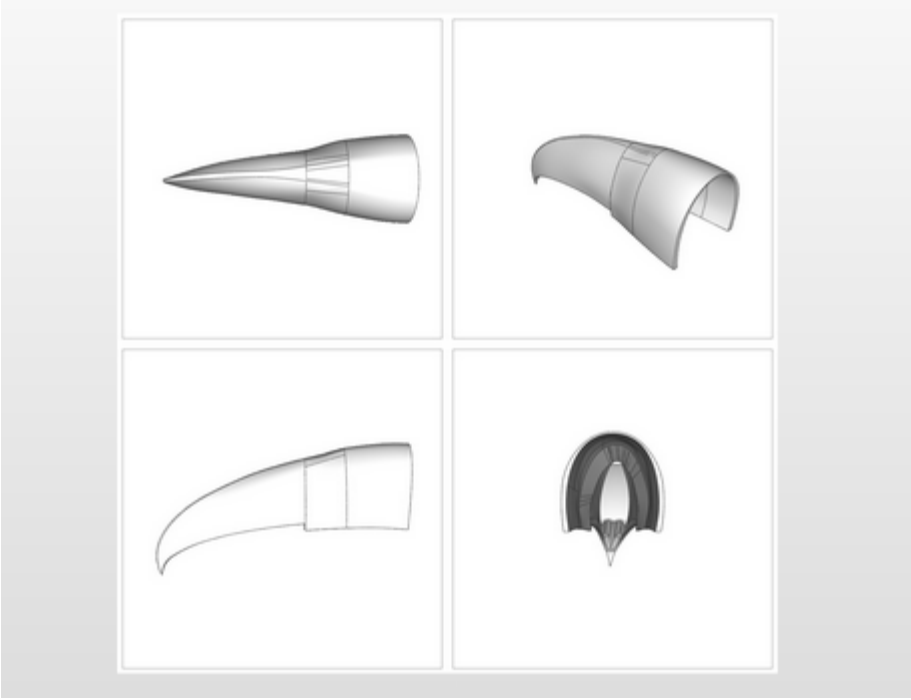
Thinner thickness

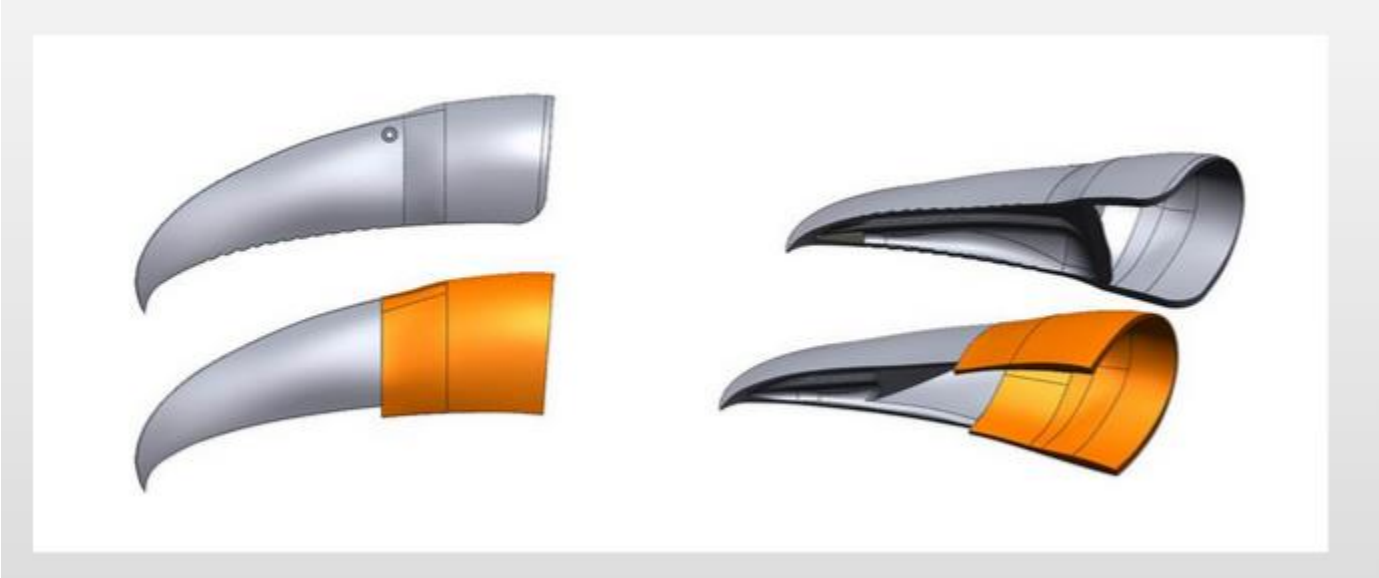
Thicker to maximize adherence

No gap to prevent food accumulating or bacteria

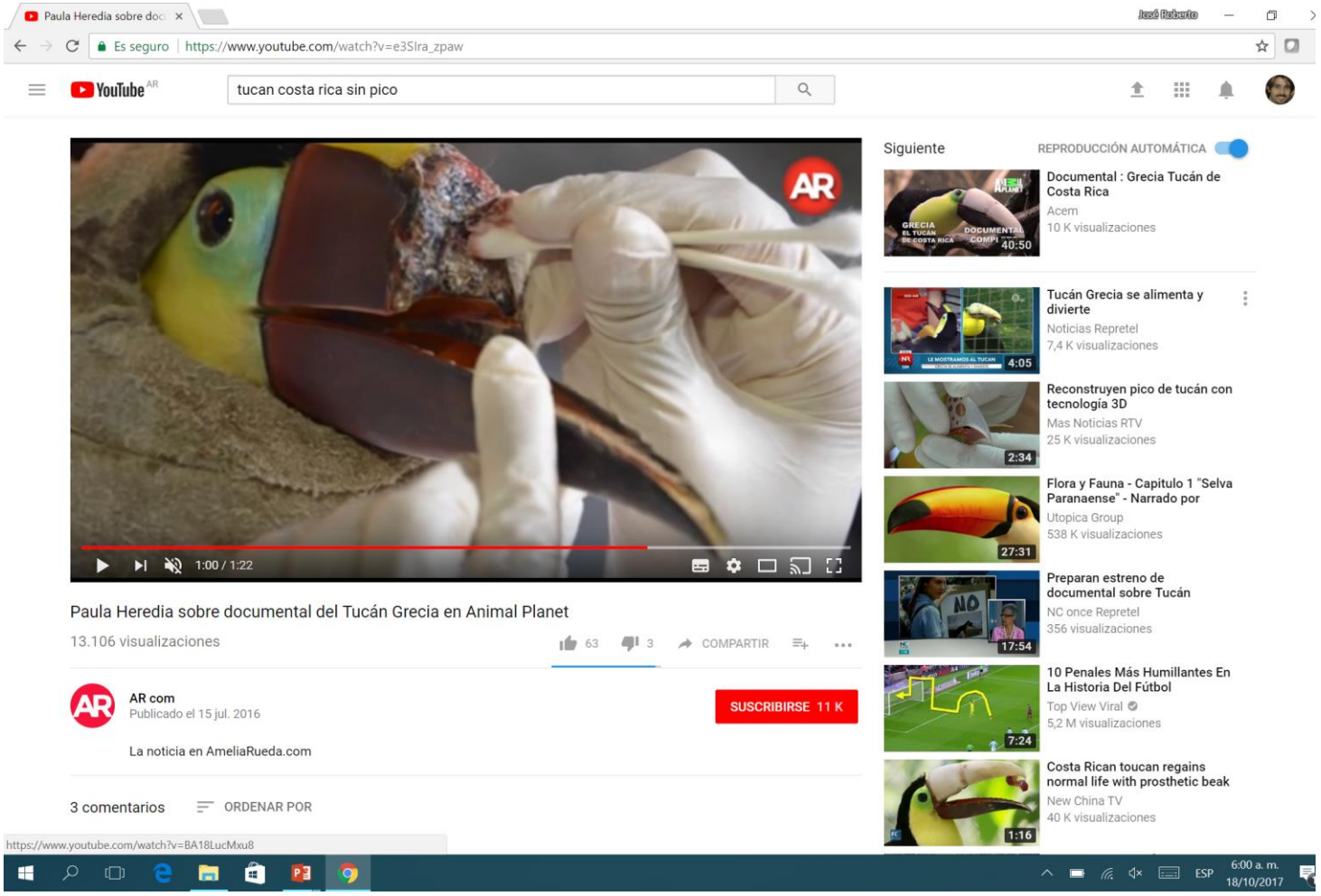
Any idea for this sealing? I'm worrying about direct touching to the wounded beak, in case of this...

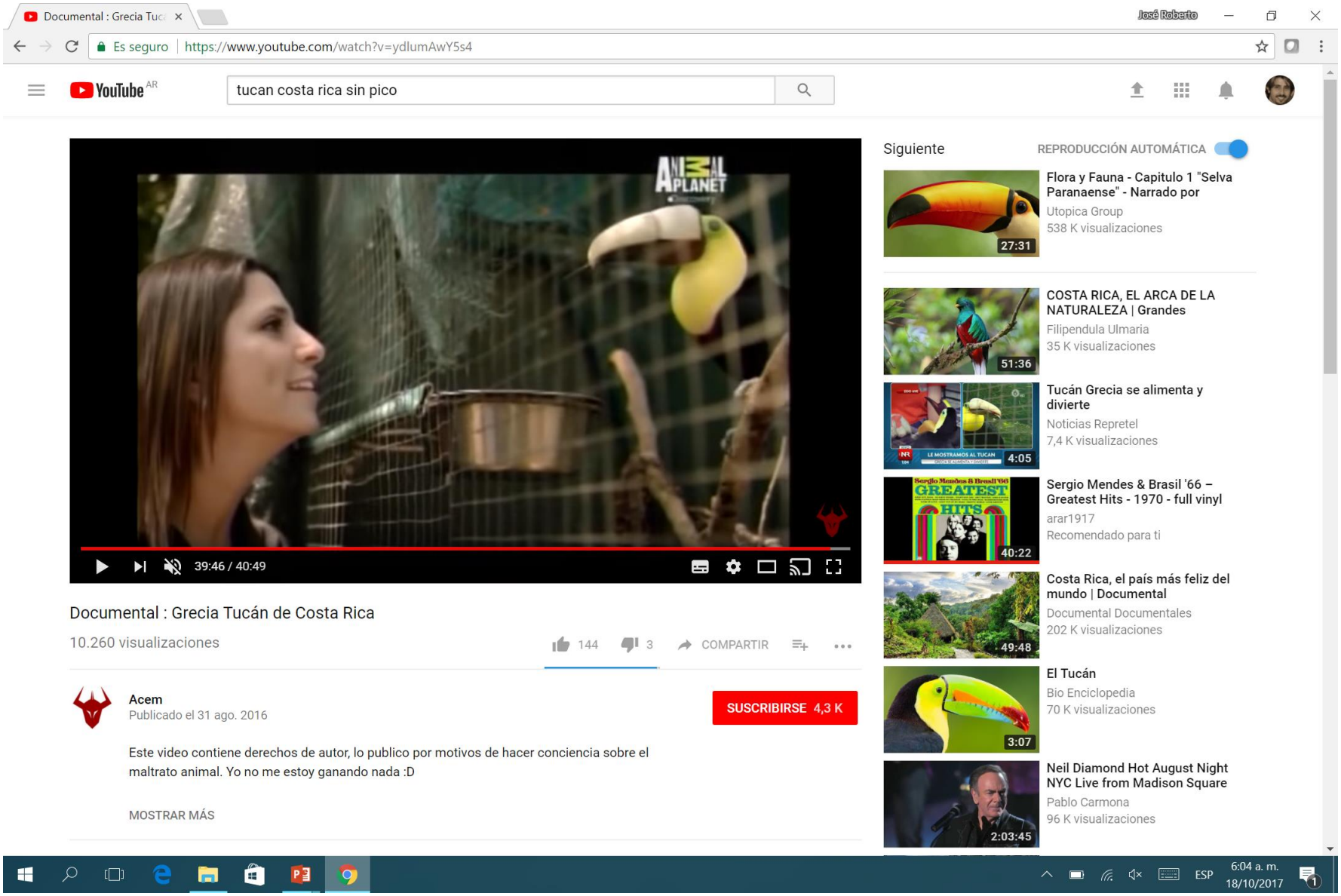






Reconocimiento mundial: ANIMAL PLANET

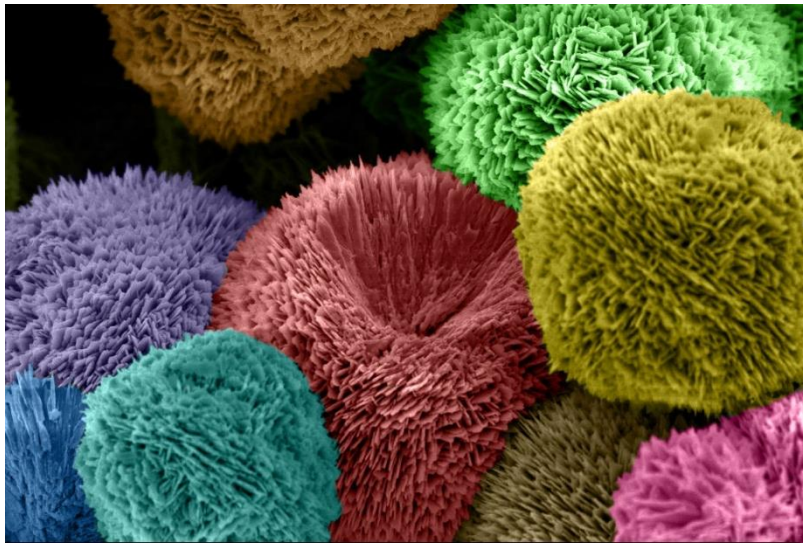


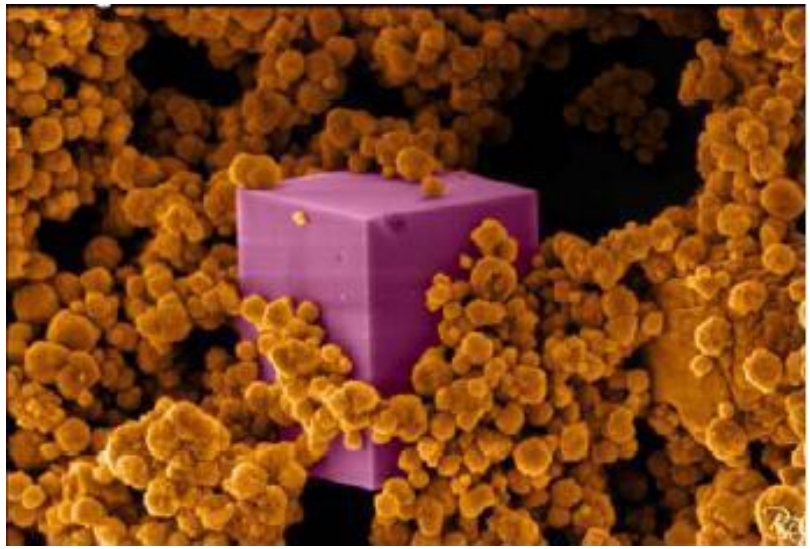

Documental : Grecia Tucá
José Roberto
Es seguro | https://www.youtube.com/watch?v=ydlumAwY5s4
YouTube AR
tucan costa rica sin pico
ANIMAL PLANET
39:46 / 40:49
Documental : Grecia Tucán de Costa Rica
10.260 visualizaciones
144
3
COMPARTIR
Acem
Publicado el 31 ago. 2016
SUSCRIBIRSE 4,3 K
Este video contiene derechos de autor, lo publico por motivos de hacer conciencia sobre el maltrato animal. Yo no me estoy ganando nada :D
MOSTRAR MÁS
Siguiente
REPRODUCCIÓN AUTOMÁTICA
Flora y Fauna - Capitulo 1 "Selva Paranaense" - Narrado por
Utopica Group
538 K visualizaciones
27:31
COSTA RICA, EL ARCA DE LA NATURALEZA | Grandes
Filipendula Ulmaria
35 K visualizaciones
51:36
Tucán Grecia se alimenta y divierte
Noticias Repretel
7,4 K visualizaciones
4:05
Sergio Mendes & Brasil '66 – Greatest Hits - 1970 - full vinyl
arar1917
Recomendado para ti
40:22
Costa Rica, el país más feliz del mundo | Documental
Documental Documentales
202 K visualizaciones
49:48
El Tucán
Bio Enciclopedia
70 K visualizaciones
3:07
Neil Diamond Hot August Night NYC Live from Madison Square
Pablo Carmona
96 K visualizaciones
2:03:45
ESP
6:04 a. m.
18/10/2017

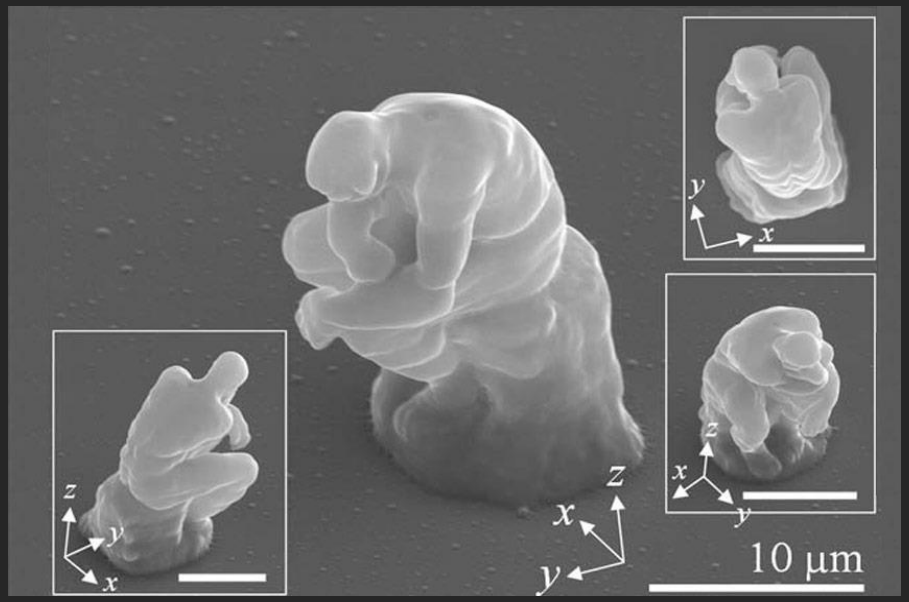
Nanoarte.

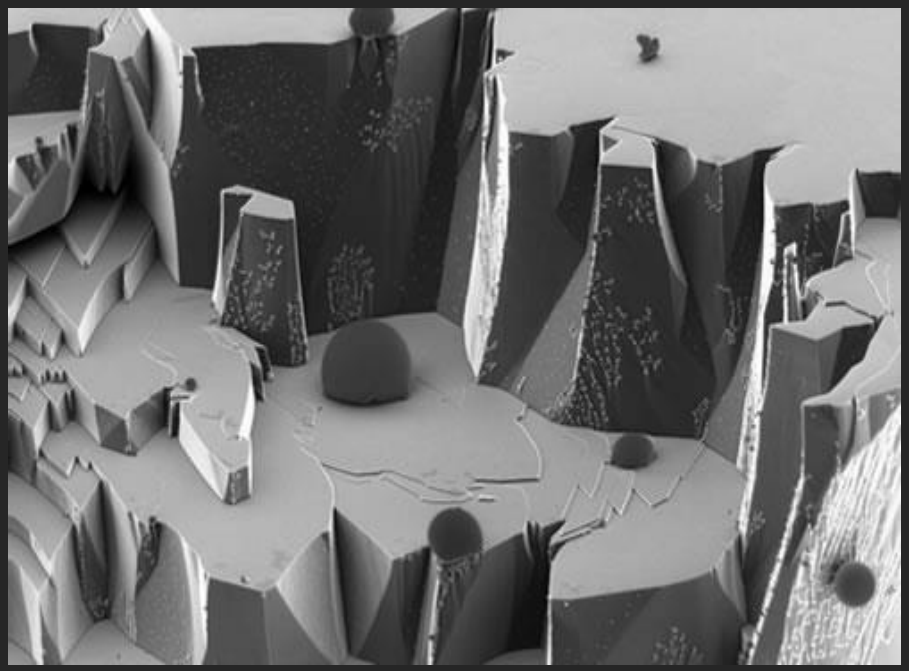
LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

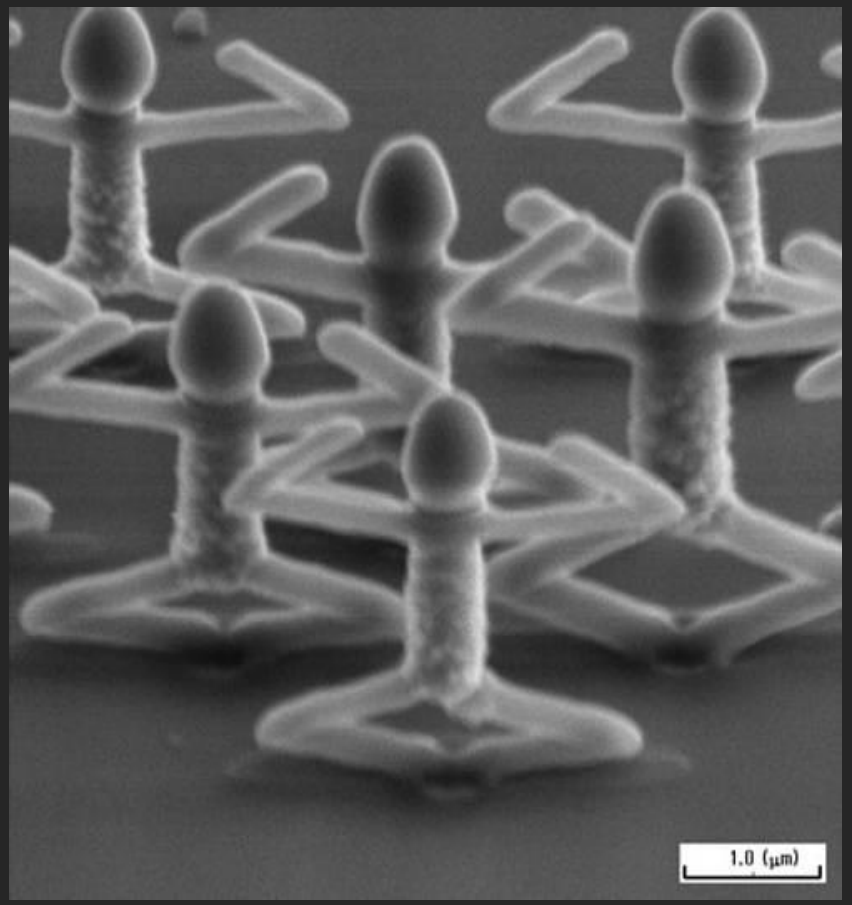
- El nanoarte pretende hacer visible lo invisible.
- El nanoarte es arte de nuevas tecnologías, pero usa frecuentemente tecnologías de la propia ciencia.
- En nanoarte es muy frecuente ver artistas que han trabajado directamente con microscopios electrónicos, con microscopias de efecto túnel, o de fuerza atómica.
- En el nanoarte la colaboración artista/científico es muy intensa.
- Arte CONTEMPORANEO conceptual: Victoria Vesna, Nanoscape de Laurent Mignonneau y Christa Sommerer.






z
y
x
y
x
z
x
y
z
x
y
10 µm




1.0 (µm)

4. Otros proyectos multidisciplinarios:

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Nodo	Tipología	Alcance
CREACION DE UN **LABORATORIO DE DOPAJE Y ANTIDOPAJE** EN COSTA RICA	Programa	Proyecto país.
NODO CENTROAMERICANO Y DE EL CARIBE PARA EL **ANALISIS CRISTALOGRAFICO DE MATERIALES**	Programa	Proyecto regional CA y El Caribe. FONDOS DE CHINA, 3.5 MILLONES $
POLITICAS PARA LA CREACION DEL **"PLAN NACIONAL DE DESARROLLO SOSTENIBLE DE LA NANOTECNOLOGIA EN COSTA RICA PNDN"**	Programa	Proyecto país
OBTENCION DE NANOCELULOSA A ESCALA INDUSTRIAL A PARTIR DE DESECHOS DE PIÑA.	Proyecto	Nacional
OBTENCION DE DEXTRANOS DE JUGO DE PIÑA	PROYECTOS	UNA, LANOTEC, CENIBIOT

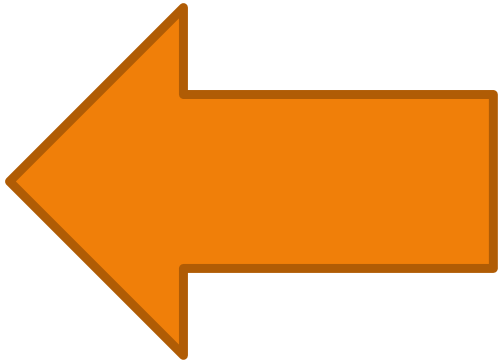
5. REDES y colaboraciones internacionales

- RED BIONNA: Bio-innovación para las Américas, inicia en 2010. CYTED.
- RED RELANS: Red Latinoamericana de Nanotecnología y Sociedad. ReLANS pretende crear un foro de discusión e intercambio de información que de seguimiento al proceso de desarrollo de las nanotecnologías en América Latina.
- RED CYTEC: Red de Comunicación de la Ciencia, la Tecnología y la Innovación de Costa Rica.
- RED CLARA: Red de Cooperación Latino Americana de Redes Avanzadas. Red CLARA interconecta a las redes académicas avanzadas nacionales de Latinoamérica.
- RED PNN: Pan-American Nanotechnology Network (PNN). Tiene como plataforma a la Global Nanotechnology Network (GNN).
- RED NANODYF-CYTED: Red de la difusión y formación en el campo de la nanotecnología.
- RED NANOENERGIA-CYTED: La plataforma Nanoenergía promueve la cooperación entre los países de Iberoamérica, desarrollando investigación básica y aplicada en diversas áreas de nanotecnología para energía limpia, como la energía fotovoltaica, baterías, LEDs y sistema de obtención de combustible con luz solar..
- RED RIN: RED IBEROAMERICANA DE NANOTECNOLOGIA.
- RED NANOANDES: escuelas de nanotecnología.
- Red NANOCELIA-CYTED: nanocelulosas de desechos agroindustriales.
- RED BIORRECER-CYTED: granos.

6. Convenios internacionales.

- ✓ FRANCIA,
- ✓ URUGUAY,
- ✓ ECUADOR,
- ✓ MÉXICO,
- ✓ ESTADOS UNIDOS,
- ✓ GUATEMALA,
- ✓ EL SALVADOR,
- ✓ COLOMBIA,
- ✓ ESPAÑA,
- ✓ PORTUGAL,
- ✓ ARGENTINA,
- ✓ PERU,
- ✓ CHINA

EN CURSO: CUBA, ALEMANIA



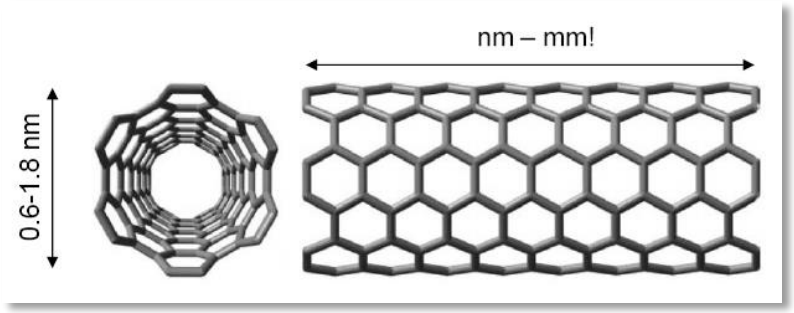
8. Pasantías de estudiantes de pre y posgrado:

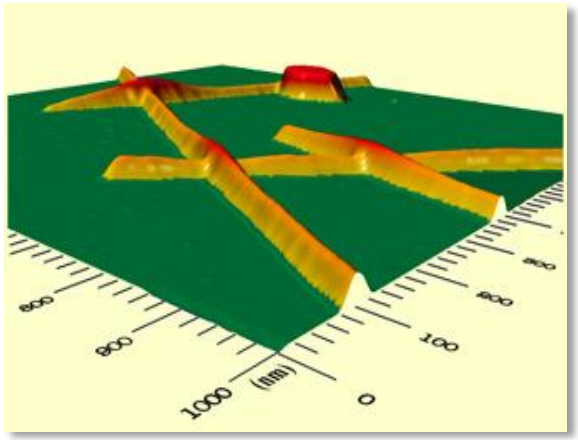
1. México: 4 estudiantes, estomatología.
2. Argentina: 4 estudiantes, materiales.
3. España: 1 estudiante, materiales.
4. Brasil: 1 estudiante, biorefinería.
5. Perú: 1 estudiante, materiales, TEM.
6. Portugal: 1 estudiante, materiales.
7. Guatemala: 1 estudiantes nov 2017.

Actividades del LANOTEC

Enmarcado en el
"PLAN ESTRATEGICO DE DESARROLLO 2016-2020" v 4.0.

La puesta en marcha del plan garantizará al LANOTEC el acceso a posiciones de liderazgo en el ámbito nacional, regional e incluso internacional.





LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

Actividades:

1. Cursos y capacitaciones.
2. Difusión de la nanotecnociencia.
3. Propuesta, elaboración y ejecución de proyectos en conjunto: U-gobierno-empresa.
4. Venta de servicios de alto nivel a la empresa.
5. Colaboraciones y actividades académicas.
6. Proyectos de extensión.
7. Proyectos de innovación.
8. Otros

LANOTEC
LABORATORIO NACIONAL DE NANOTECNOLOGIA

ADHESIVOS PARA ESPECIES MADERABLES: TEC y LANOTEC

Hindawi Publishing Corporation
Journal of Nanomaterials
Volume 2015, Article ID 895650, 15 pages
http://dx.doi.org/10.1155/2015/895650

Hindawi

Research Article

Effects of Adding Multiwall Carbon Nanotubes on Performance of Polyvinyl Acetate and Urea-Formaldehyde Adhesives in Tropical Timber Species

Róger Moya,[1] Ana Rodríguez-Zúñiga,[1] and José Vega-Baudrit[2]

[1]*Escuela de Ingeniería Forestal, Instituto Tecnológico de Costa Rica, Apartado 159-7050, Cartago, Costa Rica*
[2]*Laboratorio Nacional Nanotecnología (LANOTEC), Centro Nacional de Alta Tecnología (CENAT), San José, Costa Rica*

Correspondence should be addressed to Róger Moya; rmoya@itcr.ac.cr

Received 28 June 2015; Accepted 29 July 2015

Academic Editor: John Zhanhu Guo

Copyright © 2015 Róger Moya et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Multiwall carbon nanotubes (MWCNTs) functionalized with hydroxyl groups (MWCNTs-OH) have been incorporated into polyvinyl acetate (PVAc) and urea-formaldehyde (UF) adhesives utilized in tropical wood gluing. The Raman spectroscopy, the atomic force microscopy (AFM), and transmission electron microscopy (TEM) were used to describe the MWCNTs-OH. The adhesives were evaluated in three concentrations of MWCNTs-OH: 0% (control), 0.05%, and 0.1%. The evaluation included color, the distribution of MWCNTs-OH by TEM and AFM, thermal stability and viscosity of the adhesives, and shear strength (SS) of the glue line for nine tropical woods. AFM and TEM confirmed interaction of MWCNTs-OH with adhesives. The viscosity of the PVAc adhesive increases with added MWCNTs-OH. The incorporation of MWCNTs-OH in PVAc and UF resin produces wood adhesives with less brightness, less yellowness, and increased redness. The nanotubes in the adhesive improved the thermal stability of the composites and increased the entropy factor and energy of activation in the kinetic decomposition of the resin. In relation to SS, MWCNTs-OH in any of the two concentrations had no significant effect on SS in dry condition in half of the species studied glued with PVAc adhesive, whereas, for UF-adhesive, the SS and percentage of wood failure improved in most of the 9 species studied.

1. Introduction

Adhesives play an important role in the wood industry; 75% of the products manufactured with this material are joined together by means of adhesives [1]; among those products are composites like plywood, fiberboards, and OSB [2, 3]. The employment of adhesives has also facilitated wood utilization to make good quality products [4]. Due to their importance, production of new or enhanced adhesives has incentivized the search for new methods to increase added value in the applications [1].

Application of nanotechnology to adhesive manufacturing allows the development of new characteristics and properties in these polymers that increase their performance [2, 5]. Nanoclay, aluminum oxide nanoparticles, cellulose nanocrystals, zinc oxide nanoparticles, and carbon nanotubes are among the nanofillers utilized to enhance adhesives [6].

The unique properties of carbon nanotubes have attracted great interest since their discovery in 1991. Carbon nanotubes can be used to store fuel such as hydrogen, for new compound materials, and in catalytic applications, among others [7]. Carbon nanotubes are graphene tubular structures that may be composed of a single layer (single-wall carbon nanotubes, SWNTs) or several concentric layers (multiwall carbon nanotubes, MWCNTs) [8].

The difference between SWNTs and MWCNTs is related to their properties (chemical resistance, mechanical, thermal and electrical), which are conferred by the structure thereof and also determine their applications [8]. For example, Asgari and Lohrasbi [9] compared SWNTs and MWCNTs and they conclude that MWCNTs have durability as a support for platinum electrodes for gas diffusion. Likewise, Osswald et al. [10] mention the conductive high capacity SWCNTs compared to MWCNTs; this makes the latter more suitable

International Journal of Adhesion & Adhesives 59 (2015) 62–70

Contents lists available at ScienceDirect

International Journal of Adhesion & Adhesives

journal homepage: www.elsevier.com/locate/ijadhadh

Effects of adding nano-clay (montmorillonite) on performance of polyvinyl acetate (PVAc) and urea-formaldehyde (UF) adhesives in *Carapa guianensis*, a tropical species

Róger Moya [a,*], Ana Rodríguez-Zúñiga [a], José Vega-Baudrit [b], Vera Álvarez [c]

[a] Escuela de Ingeniería Forestal, Instituto Tecnológico de Costa Rica, Apartado, 159-7050 Cartago, Costa Rica
[b] Laboratorio Nacional Nanotecnología (LANOTEC), Centro Nacional de Alta Tecnología-CENAT, San José, Costa Rica
[c] Grupo de Materiales Compuestos de Matriz Polimérica (CoMP) – Instituto de Investigaciones en Ciencia Y Tecnología de Materiales (INTEMA), Mar del Plata, Argentina

ARTICLE INFO

Article history:
Accepted 9 February 2015
Available online 17 February 2015

Keywords:
Wood adhesives
Nanotechnology
Tropical species
Nano-clay
Thermal analysis

ABSTRACT

The aim of this study was to improve the bond strength resistance of polyvinyl acetate (PVAc) and urea-formaldehyde (UF) adhesives modified with nano-clay (montmorillonite) with a tropical species of wood known to exhibit adhesion related problems. These adhesives were evaluated with 1.0 and 1.5 wt% nano-clay concentrations with lap shear strength (SS), and the percentage of wood failure (PWF) in dry and wet conditions being evaluated. An additional aim of this study was to observe the presence of nano-clay within both adhesive types using Atomic Force Microscopy (AFM) and the Transmission Electron Microscopy (TEM). Color, viscosity and the thermostability of these adhesives with nano-clay were also evaluated. First, AFM and TEM studies showed adequate dispersion and impregnation of nano-clay. The viscosity of PVAc adhesive was not affected by the incorporation of nano-clay, whereas the UF adhesive was. With both PVAc and UF adhesives, the presence of nano-clay increased the L^* and b^* color parameters, especially when 1.5 wt% nano-clay was used. The incorporation of the nano-clay improved the thermostability, as determined by thermogravimetric analysis (TGA). Finally, it was shown that the nano-clay incorporation improved SS and PWF. The highest values of SS were obtained when nano-clay was added at 1.5 wt% concentration in the PVAc adhesive under dry conditions. SS was not affected by nano-clay addition in the UF adhesive under dry conditions. However, under wet conditions, both 1.0 and 1.5 wt% loadings of nano-clay increased SS with both adhesive types. The addition of nano-clay in both proportions increased PWF by approximately 15% and between 20–30% in dry and wet conditions, respectively, for the PVAc adhesive. For the UF adhesive, PWF increased by approximately 10% under dry conditions and 25–50% in wet conditions.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Wood adhesives and wood products are important to the manufacturing of products for construction and for furniture production [1]. Adhesives are also used to produce wood composed products, such as plywood, fiberboard and oriented strand board (OSB) and also for wood re-use [2]. It is estimated that 70% of currently marketed products use adhesives [3]. Adhesives also improve the usefulness of wood, allowing the use of low-quality wood and of small-sized pieces so that wood waste can be more effectively used [3].

In addition, many adhesives are manufactured with synthetic products, which are easy to use, present a wide variety of applications, are low-cost and are designed using high technology [3]. In this regard, the development of nanotechnology, specifically nano-particles, has helped to produce a new generation of high performance adhesives [4]. Various nano-particles, layered silicates, aluminum oxide and nanocellulose among them, have been used to improve the performance of several wood adhesives [5].

Organo-clays derived from natural montmorillonite and modified with quaternary ammonium salt (dimethyl benzyl hydrogenated tallow ammonium) have been shown to improve the properties of polyvinyl acetate [2,7–9] and urea-formaldehyde adhesives [10–13]. However, the effect of nanoparticle incorporation on the performance of adhesives used with tropical wood is still unknown. While the behavior of adhesives with nano-particles is relatively well understood in temperate countries, in regions of high temperature and high humidity, such as in tropical countries, it can create many problems [14]. Furthermore, tropical species have high specific gravity and high contraction coefficients

* Corresponding author.
E-mail addresses: rmoya@itcr.ac.cr (R. Moya), ana.rodriguez@itcr.ac.cr (A. Rodríguez-Zúñiga), jvegab@gmail.com (J. Vega-Baudrit), alvarezvera@fi.mdp.edu.ar (V. Álvarez).

http://dx.doi.org/10.1016/j.ijadhadh.2015.02.004
0143-7496/© 2015 Elsevier Ltd. All rights reserved.

Adhesivos con NTC

Adhesivos con montmorilonita

Dispositivos médicos intrauterinos: HOLOGIC → ETICA

Journal of Biomaterials and Nanobiotechnology, 2015, 6, 247-256
Published Online October 2015 in SciRes. http://www.scirp.org/journal/jbnb
http://dx.doi.org/10.4236/jbnb.2015.64023

Micro, Meso and Macro Porous Materials on Medicine

Victor Solano-Umaña[1], José Roberto Vega-Baudrit[2]

[1]Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, DOCINADE Science PhD Student, San José, Costa Rica
[2]PhD, National Nanotechnology Laboratory (LANOTEC-CeNAT-CONARE), San José, Costa Rica
Email: Victor.solano@hologic.com, jvegab@gmail.com

Received 4 August 2015; accepted 5 October 2015; published 8 October 2015

Copyright © 2015 by authors and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

An enormous development is experimented on the porous materials. The porous was considered a defect on solid materials some years ago, but right now, this defect is an advantage, based on the properties obtained from a micro and mesoporous materials. Microporous, mesoporous and macroporous materials with an uniformed pore distribution offer new properties, such as absorption, adsorption, exchange separation, and catalysis of different compounds, also they can play different roles as hosts for a nanocomposite materials to modify or improve their properties. Today, the structural types of open framework porous compounds have rapidly increased by their unique structural properties, porous size window and accessible void space are critical factors on a medical application.

Keywords

Microporous, Mesoporous, Macro Porous

1. Introduction

Immense research during the last decade has been devoted to adjust the morphology (the size and shape) of solids at various length scales from the nanometer to the micrometer scale [1]. The porous materials research has been done with a variety of pore sizes, shapes and densities, but the crucial feature is the increase in the material surface, which helps improve property absorbent and adsorbent properties [2] [3]. Modifying the surface of materials, you can obtain materials with different porous size.

Porous materials are classified by the pore size; the International Union of Pure and Applied Chemistry (IUPAC) classify the porous materials in:

How to cite this paper: Solano-Umaña, V. and Vega-Baudrit, J.R. (2015) Micro, Meso and Macro Porous Materials on Medicine. *Journal of Biomaterials and Nanobiotechnology*, 6, 247-256. http://dx.doi.org/10.4236/jbnb.2015.64023

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 6, Issue, 9, pp.6389-6395, September, 2015

International Journal of Recent Scientific Research

ISSN: 0976-3031

RESEARCH ARTICLE

ETHIC IN NANOTECHNOLOGY

Solano Umaña, Victor[1]., Vega-Baudrit José Roberto[2] and González-Paz Rodolfo[3]

[1]Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science DOCINADE- Costa Rica
[2]National Nanotechnology Laboratory (LANOTEC-CeNAT-CONARE), San José, Costa Rica

ARTICLE INFO

Article History:

Received 05th June, 2015
Received in revised form 08th July, 2015
Accepted 10th August, 2015
Published online 28th September,2015

Key words:

Ethics, nanotechnology, nanoscience, nanomaterials, nanoparticles.

ABSTRACT

Emerging and Readily Available Technologies and Security is a study on the ethical, legal, and society issues relating to research, development, and used of rapidly changing technologies with low barriers of entry that have potential applications, such as information management, synthetic biology, and nanotechnology. The nanotechnology sector, which generated about $11.5 billion in product sales in 2009, is predicted to expand rapidly over the next decade. The increasing production and use of engineered nanomaterials may lead to greater exposures of workers, consumers, and the environment, and the unique scale-specific and novel properties of the materials raise questions about their potential effects on human health and the environment. For this reason government agencies, academic institutions, industry, and others have conducted many assessments of the environmental, health, and safety aspects of nanotechnology.

Nanotechnology has many prospects for improving the quality of life of humans and solving problems related to poverty, health, and the environment. However, it can also have a negative impact if it is not used in accordance with ethical principles. It is not a panacea for our ills.

Copyright © Solano Umaña, Victor., Vega-Baudrit José Roberto and González-Paz Rodolfo.2015. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Today Nanoscience and Nanotechnology are seen as transformative movements, which have a big potential to stimulate and improve innovation in all areas of life. They could greatly benefit our society, but this new science includes many concerns about possible risks to human health and environment.

Nanotechnology has been established as a priority research and policy focus, cutting across several R&D fields from pharmaceutics, food and electronics. The raise of nanotechnologies has been accompanied by an enduring uncertainty characterizing the developments of the scientific knowledge related to this field, as well as the social trajectories of technological applications. Such a condition inevitably affects regulatory responses to such technologies, their development and their uses (Arnaldi and Muratorio, 2013).

One of the main concerns about human health risk is the possibility of the nanoparticles to pass through the cell membrane and interact with biomolecule components, but this property is used precisely to target infect cells, deliver drug agents on this cells and kill them. The behavior of nanomaterials at the nano level is curiously unpredictable from behavior at the macro or even micro level. We have thus found new and wonderful uses for some old standbys, but we have been surprised and, predictably, will continue to be surprised by the effects of nanoparticles. Nanoparticles are so small; they can go through cell membranes. That is part of the point of nanotechnology, of course, some nano - artifacts are to deliver lethal drugs precisely to wayward cells, for example, killing only them. The concern is that such tiny particles may migrate into cells where they could do great damage in the brain, for instance (Robinson, 2011)

The environment concern is related to a possible eco-toxicity, when the nanomaterials reach landfills, water or air because the nanomaterials could harm the eco-systems also it could be a potential exposure, because they can coming into our body by breath, drinking or eating, be deposited in the lungs or on the skin, or other organs. However, agglomerates of nanoparticles may have the potential to express toxicity.

NPs (nanoparticles) may enter the human body via the lungs and the intestines (if ingested); penetration via the skin is less evident but it is possible that some NPs can penetrate deep into the dermis. NP internalization depends on the particle size,

Corresponding author:* **Solano Umaña, Victor
Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science DOCINADE- Costa Rica

ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 6, Issue, 9, pp.6290-6295, September, 2015

International Journal of Recent Scientific Research

RESEARCH ARTICLE

POROUS SIZE CONTROL ON SILICONE MATRIX

Solano-Umaña Victor[1]*and Vega-Baudrit, José Roberto[2]

[1]Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science Docinade- Costa Rica

[2]National Nanotechnology Laboratory (Lanotec-Cenat-Conare), San José, Costa Rica

ARTICLE INFO

Article History:

Received 16th June, 2015
Received in revised form 24th July, 2015
Accepted 23rd August, 2015
Published online 28th September, 2015

Key words:

Microporous, Mesoporous, Macroporous, Mesostructured, Biomaterials.

ABSTRACT

An enormous development is experimented on the porous materials. The porous was considered a defect on solid materials some years ago, but right now, this defect is an advantage, based on the properties obtained from micro, meso and macroporous materials, and their possible applications on a medical field. The feasibility to use forming agents to control the density and size of the pores, and the possibility to improve the porous properties through adding functional groups or nanoparticles on the porous surface allows the application of porous materials in many areas, especially on medicine.

Copyright © Solano-Umaña Victor *et al* 2015, This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

The porous material is a continuous and solid network material filled through and with voids, a material that is obviously porous when the voids are filled up with gas. However, the voids might be filled with a liquid or even a solid; some authors prefer to label nanostructured materials instead of porous material (Polarz, 2004).

Immense research during the last decade has been devoted to adjust the morphology (the size and shape) of solids at various length scales from the nanometer to the micrometer scale (Kuschel, and Polarz, 2008; Qin, Ren, Zhu, Zhang, Shang, and Wei, 2011). The porous materials research has been done with a variety of pore sizes, shapes and densities, but crucial feature is the increase in the material surface, which helps improve absorbent and adsorbent properties (Mitra, Vazquez- Vazquez, Lopez-Quintela, Bidyut, and Bhaumik, 2010; Park, Jung, Myung, Kim, Moon, Shin, and Seo, 2008).

Porous materials can be made with a variety of pore sizes, modifying the surface of materials that can obtain materials with micro-pores, surfaces with holes less than 2 nm, nanoporous, materials with pore size between 2 nm and 50 nm and macropores, materials with pore size greater than 50 nm, sizes and densities could be controlled by the formation conditions, but crucial feature is the increased surface that gives new properties to the materials (Yamauchi, Suzuki, Radhakrishnan, and Wang, 2009).

Porous materials can be manufactured using many substances such as carbon, silicates, ceramics, minerals and polymers (silicone). Attached to the advantage of the porous material, these micro, nano and macro channels can be coated with metallic nanoparticles to improve their properties. Most of the researches that have been designed to provide porous materials with surface functionality, where the structure can be functionalized with organic aliphatic or aromatic groups interact with metal (Orin, and Arsenault, 2005).

Biocompatible implants allow the human body to restore biological and mechanical functions; therefore, to manage to increase the quality of life. Depending on the biomedical application, the implant has to withstand mechanical loads, while conducting a long term biological interaction with the surrounding biological tissue is promoted. The bulk properties of the implant are primarily responsible for the load bearing capacities, where the interaction with the surrounding tissue is governed by the implant surface. (Zhang, 2011).

The Porous materials could be made with the use of organic compounds that can act as templates or pore-forming agents,

*Corresponding author: **Solano-Umaña Victor**
Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science Docinade- Costa Rica

Journal of Chemistry and Biochemistry
June 2015, Vol. 3, No. 1, pp. 21-33
ISSN 2374-2712 (Print) 2374-2720 (Online)
Copyright © The Author(s). 2015. All Rights Reserved.
Published by American Research Institute for Policy Development
DOI: 10.15640/jcb.v3n1a2
URL: http://dx.doi.org/10.15640/jcb.v3n1a2

Gold and Silver Nanotechology on Medicine

Solano-Umaña, Victor[1] & Vega-Baudrit, José Roberto[2]

Abstract

The new researches about the application of noble metals (nanoparticles, nano-films, nanostructure, etc) to the medical field are one of the most exciting topics. Diagnostics, Drug Delivery, Photo-Thermal Ablation, Medical Imaging, Biomarkers, and Antimicrobial Coatings are examples of this new technology that the human can be reach with this acknowledge. Owing to wide ranging applications of noble metal nanoparticles, nanocompounds or nanostructures in diverse areas of science and technologies, the medical application is one of the more impacted areas, this impact also impacted human quality live. The nanotechnology promise of providing great benefits for society in the future is in the realm of medicine.

Keywords: Nanoscience, Nanotechnology, Nanomedicine, Silver and Gold

Introduction

The surface modifications for polymers or applying coatings using metal nanoparticles increase the biocompatibility properties, nanofilms since favor interaction of living cells with the biomaterial, especially for its beneficial effect on cell adhesion and proliferation. Along with the control of porosity in these materials, the application of metal helps allow vascularization and the growth of cells inside. The key biological processes integration, protein adsorption and cell proliferation, is the use of chemical methods to modify the properties of the surface of biocompatible materials, (Variola, Vetrone, Ricert, Jedrzejowski, Yi, Zalzal, Clair, Sarkissian, Perepichka, Wuest, Rosie, & Nanci, 2009), Nanotechnology had tremendous impact on medical science and has resulted in phenomenal progress in the field of drug delivery and diagnostics, (Doshi, & Mitragotri, 2009).

[1] Environmental Management Master Degree, Senior Chemist Hologic Surgical Products, Science PhD student DOCINADE-Costa Rica. Phone: (506) 24362739, E-Mail: Victor.solano@hologic.com
[2] PhD, National Nanotechnology Laboratory (LANOTEC-CeNAT-CONARE), San José, Costa Rica, Phone: (506) 25195835, E-Mail: jvegab@gmail.com

Resultados 2010-2016

Actividad		Año						
		2010	2011	2012	2013	2014	2015	2016
Proyectos	Cantidad de proyectos	15	8	12	18	19	30	42
	Tesiarios relacionados	24						14
Productos	Publicaciones revistas indexadas.	8	6	13	10	9	24	36
	Estudiantes en proyectos.	36						26
	Estudiantes becados.	na	na	na	1	3	3	6
	Actividades capacitación impartidas.	4	5	6	14	15	8	14
	Ponencias presentadas.	12	5	29	24	12	19	70
	Servicios u otras actividades: otras actividades.	16	26	35	43	58	80	85
	Organización y participación en otras actividades.	12	9	8	6	4	15	6
	Publicaciones en libros.	--	--	3	--	4	1	4
	Redes relacionadas	13						13
	Convenios de colaboración	19						6+
	Reconocimientos	10						6
Becas Cenat		na	na	na	1	3	3	6

jvegab@gmail.com

José Roberto Vega-Baudrit