

# Recubrimientos basados en nanocolumnas fabricadas por sputtering: propiedades antibacterianas, ópticas y anti-multipactor.

Dr. José Miguel García-Martín



INSTITUTO DE MICROELECTRÓNICA DE MADRID  
(CENTRO NACIONAL DE MICROELECTRÓNICA)



A. Palmero



UNIVERSIDAD  
COMPLUTENSE  
MADRID

M. Vallet-Regi



Hospital  
Universitario  
Fundación  
Jiménez Díaz

J. Esteban



I. Fernández



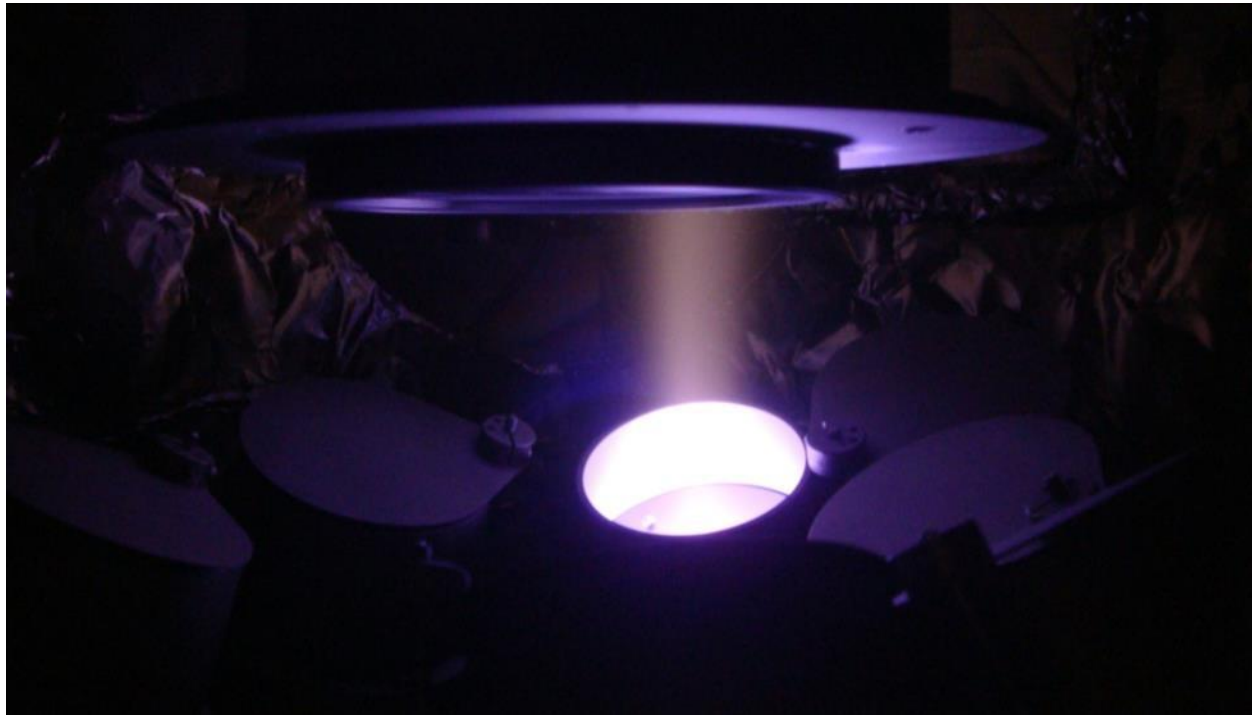
L. Soriano

## Introducción: pulverización catódica o sputtering

Técnica física en vacío

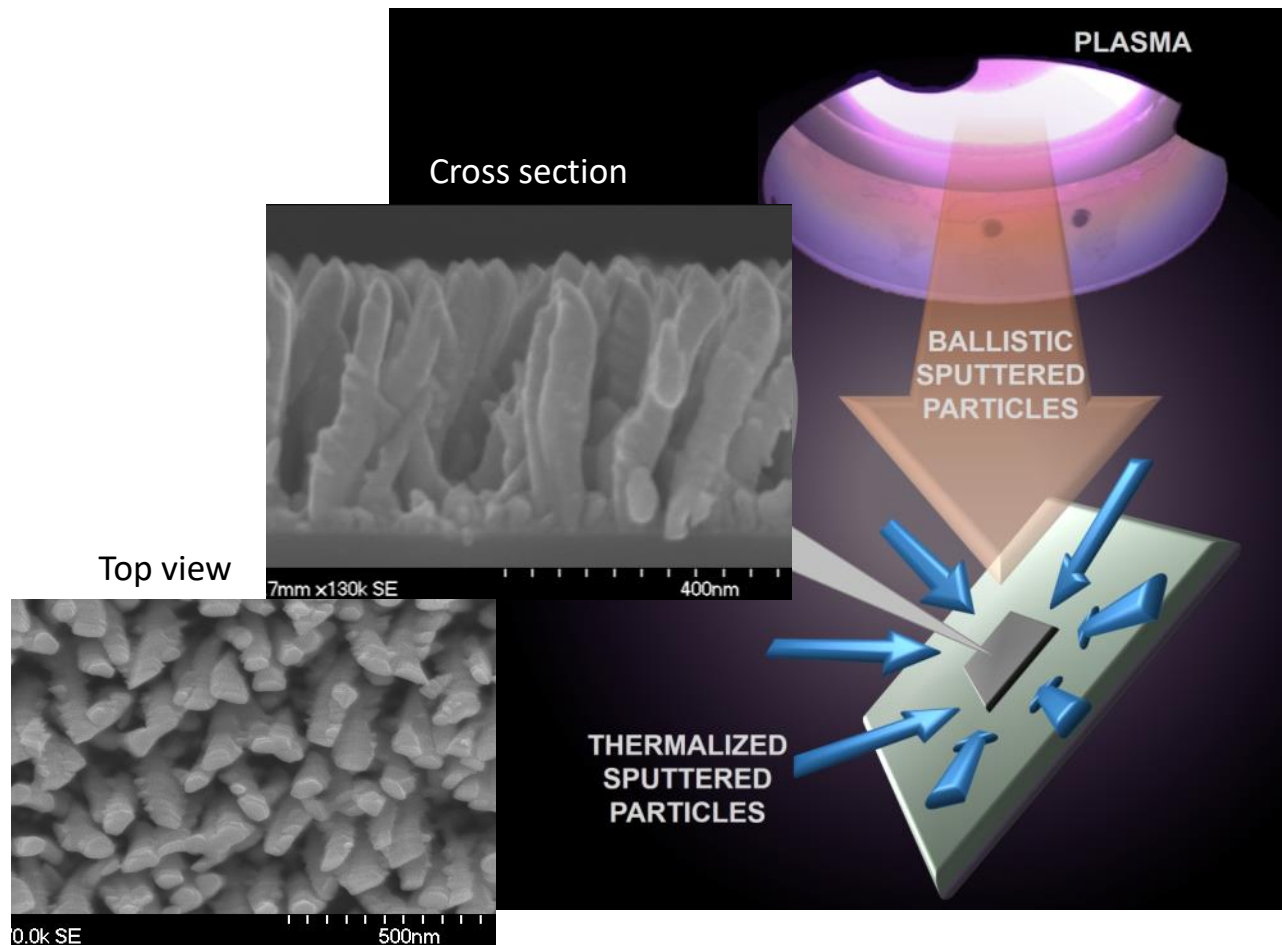
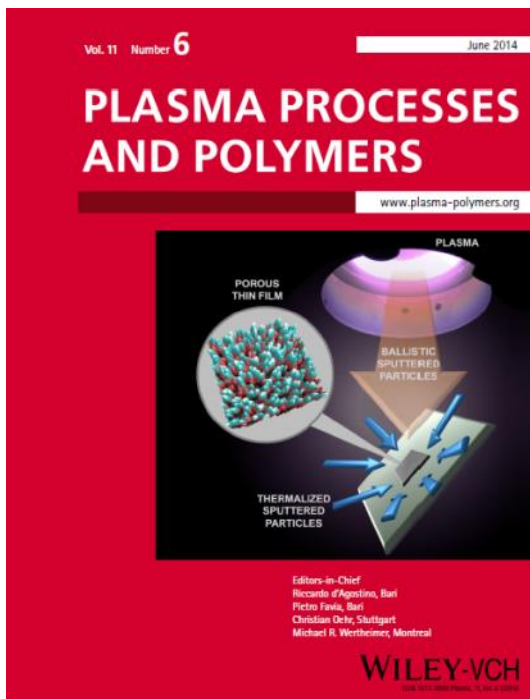
Bajo coste Energético

Escalable



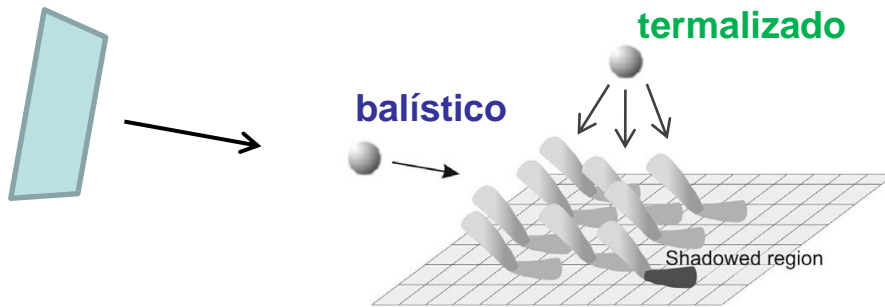
# Fabricación de Nanocolumnas por GLAD sputtering

## Incidencia Oblicua: nanocolumnas



# Fabricación de Nanocolumnas por GLAD sputtering

## ➤ Autosombreado atómico



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### Explaining magnetron sputtering growth of nanoporous thin films

April 18, 2014 By MaterialsViews staff [Leave a Comment](#)

Plasma-assisted techniques are regularly used to fabricate compact and dense films for microelectronics and protective coatings for a wide range of applications (from turbine blades to food and beverage). The past few years have witnessed the development of new deposition modes at oblique angles that allow the synthesis of nanoporous materials, of interest for numerous technological fields, such as self-cleaning surfaces, fuel cells, microfluidic devices, or solar cells, to name a few. In these cases, the formation of nanopores is the outcome of self-shadowing effects when vapor species arrive at the film surface along a tilted direction.

With these developments in mind, researchers from the Spanish Research Council (CSIC) have developed a fundamental framework to explain the growth of nanoporous thin films when the magnetron sputtering technique is used. They have described the transport of vapor species through a plasma towards a tilted

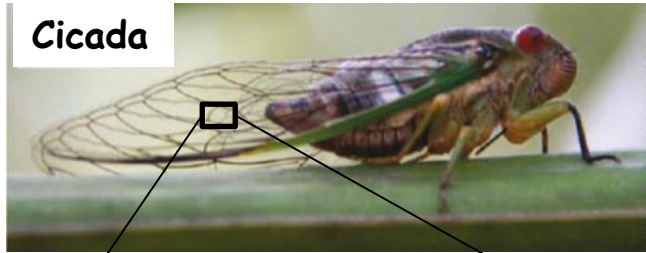
App. Phys. Lett. **97**,173103 (2010)

Nanotechnology **24**,045604 (2013)

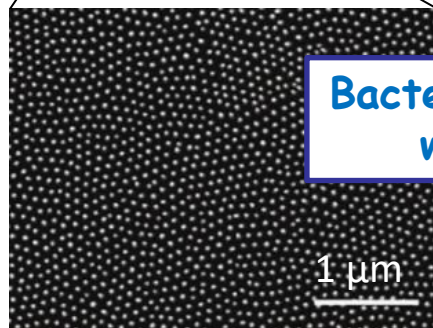
Plasma Process. Polym. **11**, 571 (2014)

J. Phys. D: Appl. Phys. **49**, 045303 (2016)

# Nanocolumnas de Ti: recubrimientos antibacterianos

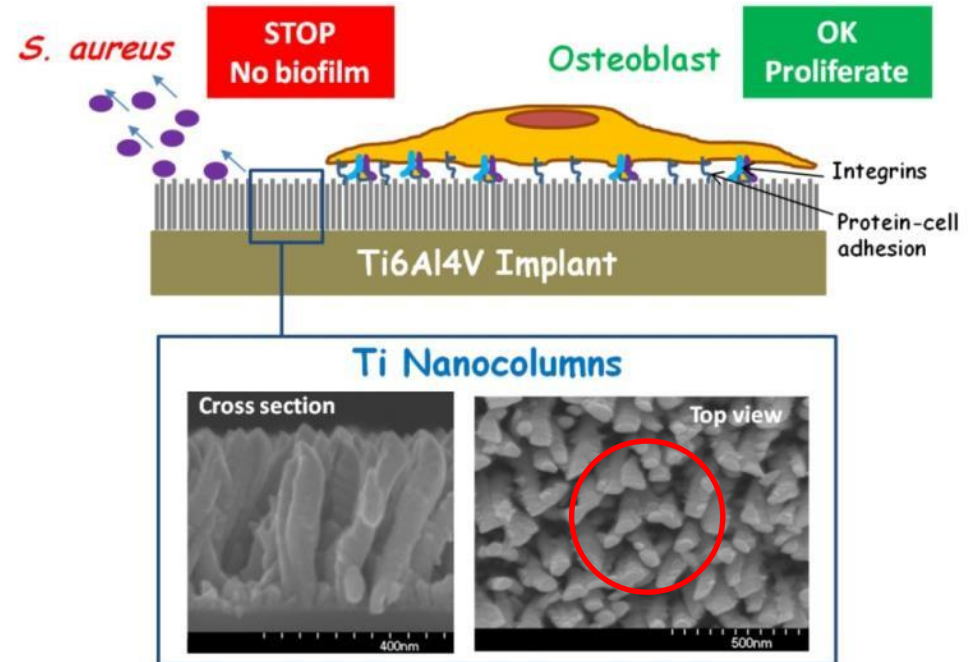


Cicada

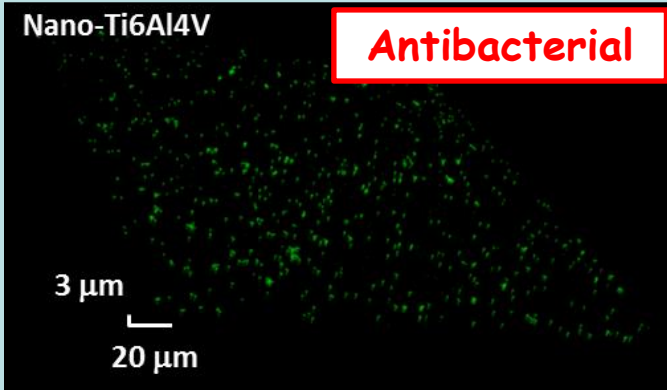
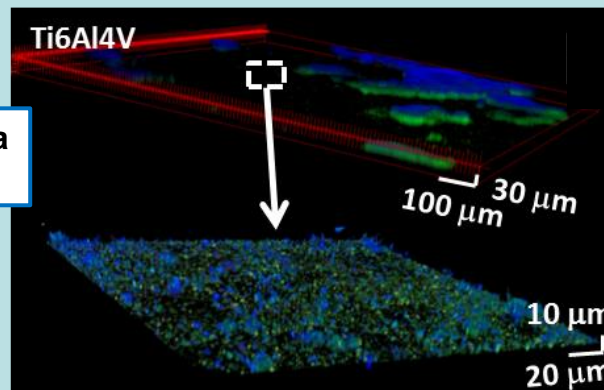


Bacteria-free wings

Ivanova et al *Small* 2012, 8, 2489.



Microscopía de Fluorescencia  
azul indica infección



# Nanocolumnas de Ti: recubrimientos antibacterianos

## El proyecto NANOIMPLANT

- **Patente PCT/ES2015/070345**
- **Ganador de IDEA2 (Madrid-MIT)**

Madrid-MIT  
**m+VISIÓN**  
CONSORTIUM



Massachusetts  
Institute of  
Technology

IDEA<sup>2</sup> MADRID

### IDEA<sup>2</sup> Madrid 2014 Awardees



#### Nanoimplant: Nanostructured coatings for orthopedic implants

*José Miguel García-Martín, Rafael Álvarez, Alberto Palmero, Isabel Izquierdo-Barba, Daniel Arcos, María Vallet-Regí*

Developing a biocompatible and bacteria-inhibiting orthopedic implant using nanostructured coatings.

EFE: FUTURO

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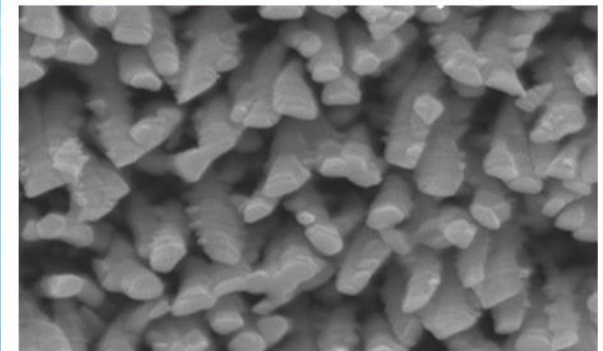
CENCIA NANOTECNOLOGÍA

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## Nanoestructuras de titanio para implantes óseos

EFEFUTURO - Un equipo internacional de investigadores ha desarrollado una estructura de titanio para recubrir los implantes óseos, un avance que permitirá reducir el riesgo de infección y el rechazo que provocan estas intervenciones.

EFEFUTURO MADRID | VIERNES 09 DE 2015



Vista cenital de las nanocolumnas de titanio del recubrimiento para implantes óseos. (Foto: CSIC)

El estudio, realizado por miembros del Consejo Superior de Investigaciones Científicas (CSIC) y de la Universidad Complutense de Madrid, se ha publicado en la revista Acta Biomaterialia.

Las propiedades antibacterianas de este hallazgo, patentado por el CSIC y la Universidad, se deben a la formación de una superficie nanoestructurada **similar a la que se observa en las alas de las cigarras y en las hojas de la flor de loto.**

Los científicos han logrado esta propiedad sin necesidad de emplear elementos antibióticos, precisa el CSIC en una nota.

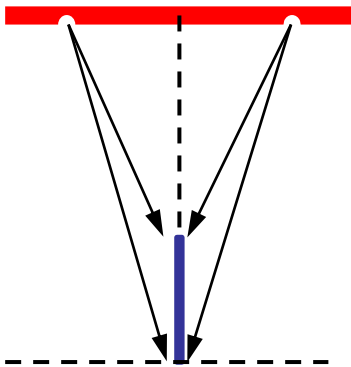
(más de 90 reseñas)

# Escalado de los recubrimientos antibacterianos

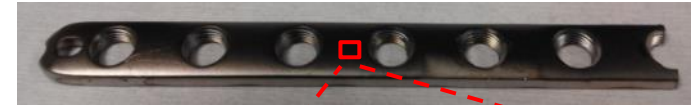


Fundación  
Domingo  
Martínez

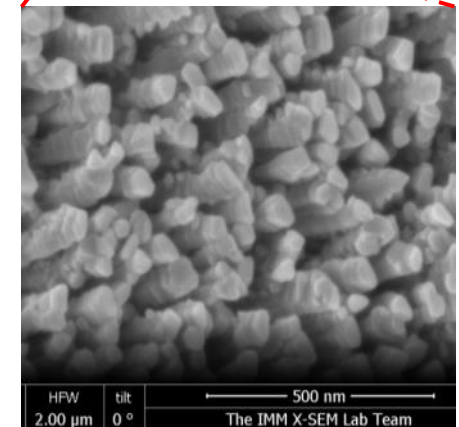
nano4ENERGY



Initial (L=12cm)



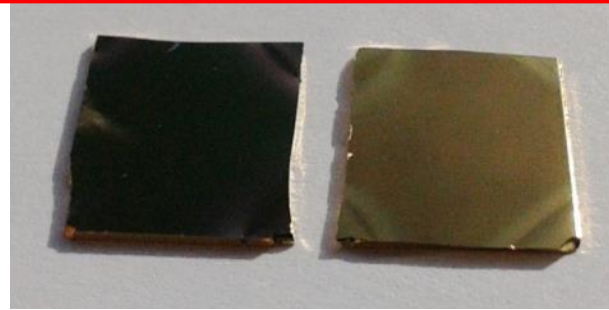
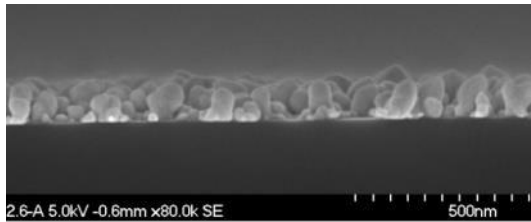
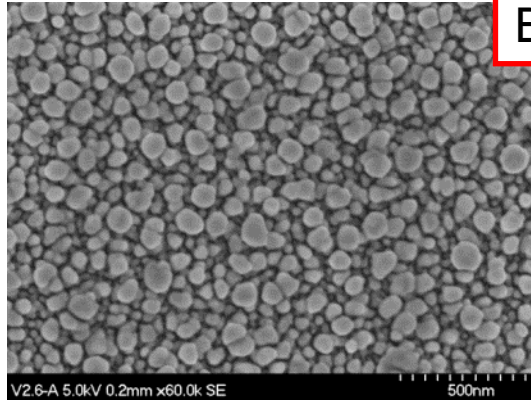
coated



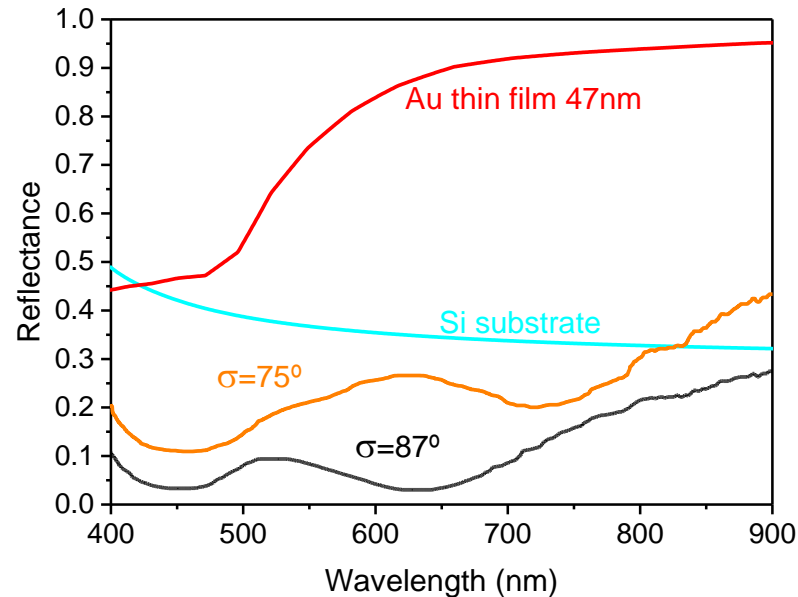
HPW 2.00 μm tilt 0 ° 500 nm  
The IMM X-SEM Lab Team

# Nanocolumnas de Au: metal negro

Patente **PCT/ES2015/070516**  
Beilstein J. Nanotechnol. **8**, 434 (2017)



**87°** Tilt angle **75°**

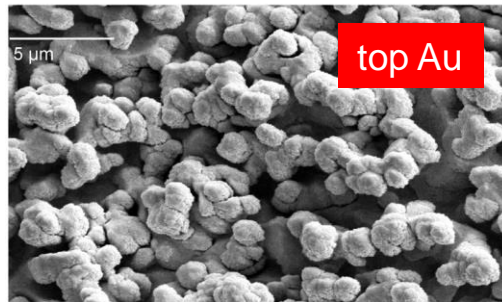
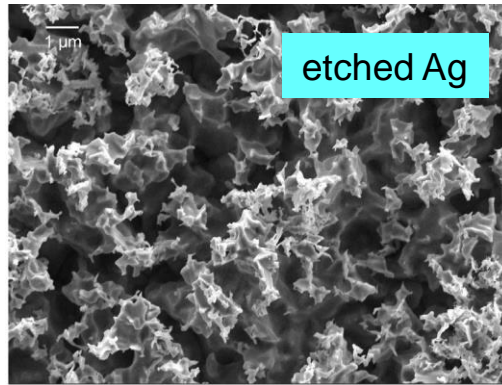
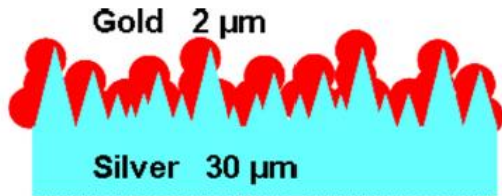


## Applications

- radiative heat exchangers
- solar energy absorbers
- separators to avoid cross effects in optical devices
- thermal light emitters
- biosensors electrodes
- etc...



# Recubrimientos Anti-multipactor



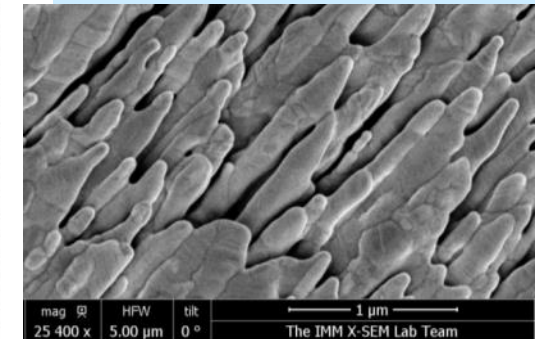
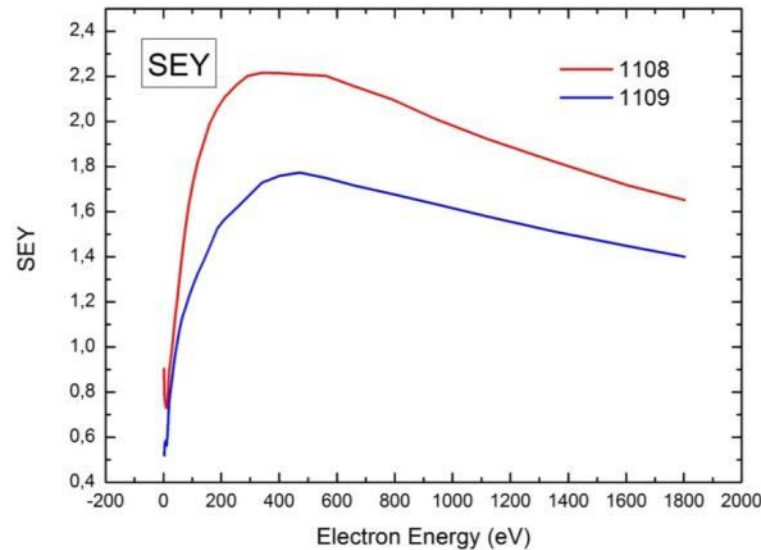
Nistor *et al.*,  
Appl. Surf. Sci. 315, 445 (2014)

➤ Evitar avalanchas electrónicas en vacío

Colaboración:  
Prof. L. Soriano



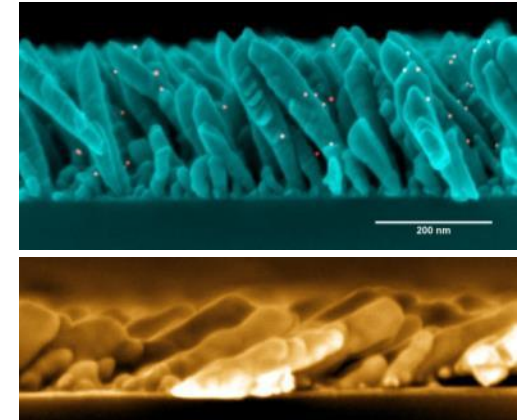
Nanocolumnas de Ag



## Conclusiones

### Recubrimientos basados en Nanocolumnas

- Fabricación por sputtering (escalable)
- Propiedades antibacterianas
- Absorbente en el visible (metal negro)
- Efecto anti-multipactor



josemiguel.garcia.martin@csic.es

Abiertos a colaboraciones  
¡ Gracias por su atención !

# Complementarias

## Capacidades singulares para Nanocolumnas

### UHV Sputtering system for metals and dielectrics

- 6 magnetrons (AJA)
- DC and RF power supplies
- Fully moveable holder: tilt and rotation, i.e. suitable for GLAD
- Heater up to 700 °C



### XHR-SEM ( Extreme High Resolution)

- Subnanometer Spatial resolution: 0.6 nm at 15 kV / 0.7 nm at 1 kV
- 5 different detectors for simultaneous and uncoupled topography / material contrast
- Extreme performance with isolating / fragile samples at very low landing energies down to 20 eV
- Quantitative element/phase analysis and mapping by EDX

## Otras capacidades singulares



### nano-Focused Ion Beam

- IonLINE: ion-beam lithography, nanofabrication & engineering workstation (nanoFIB, resolution: 15 nm)
- Interferometer controlled stage (fabrication area up to 100 cm<sup>2</sup>)
- Gas Injection System (GIS)

### Scanning Probe Microscopy

- Atomic force microscopy (AFM): morphology
- Magnetic force microscopy (MFM): magnetic structure
- Quantitative nanomechanical properties (QNMP): Young modulus, adhesion, dissipation, and deformation

