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Simulation of Photonic Crystals Particle Filling By Electrospray Ionization

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COMSOL, 2010,Paris

Outline

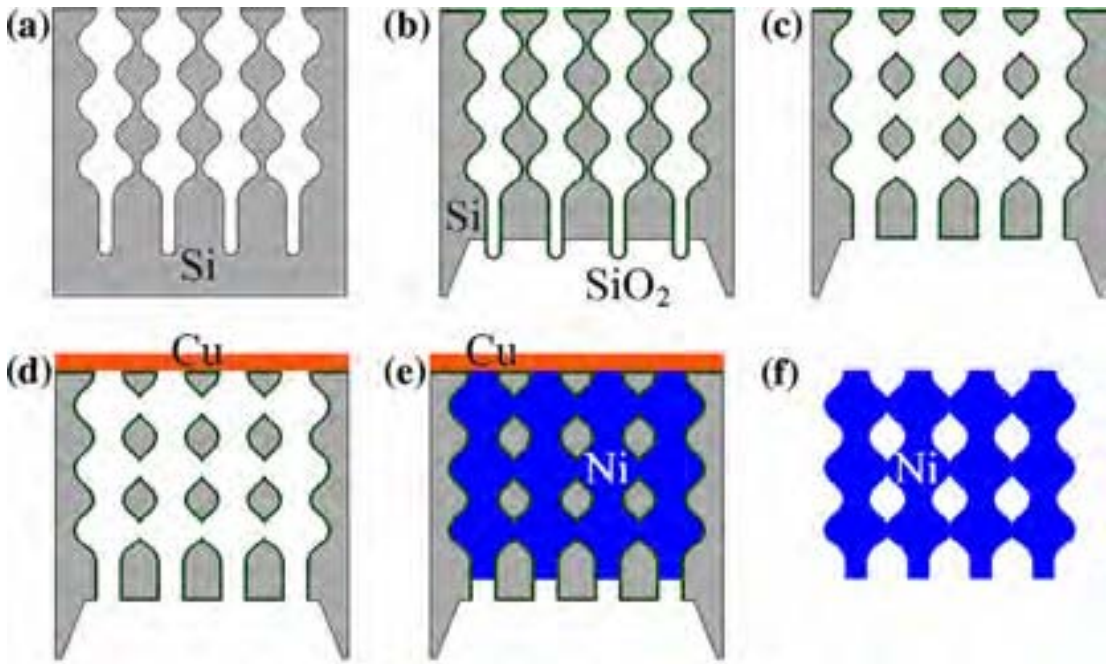
Introduction

Objective

The main objective of this simulation is to check the possibility of filling photonic crystals by the means of electrospray. With simple simulations we were able to get an approximated reference about the feasibility of this technique.

Filling of photonic crystals

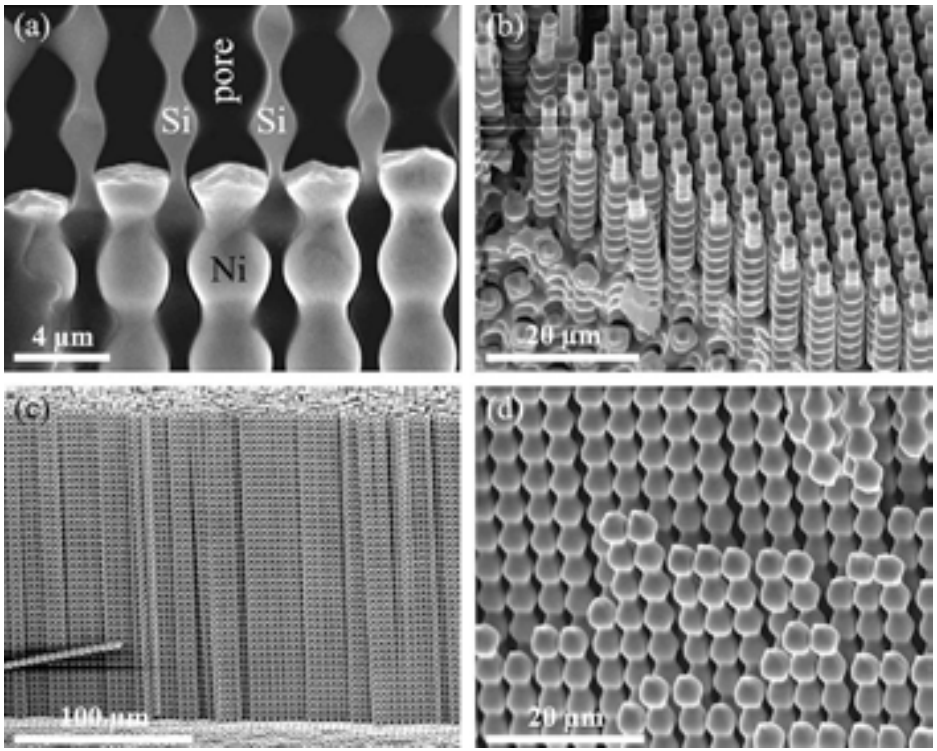
- Filling with electroplating technique



D. Hernández et al. "3D metallo-dielectric structures combining electrochemical and electroplating techniques"

Filling of photonic crystals

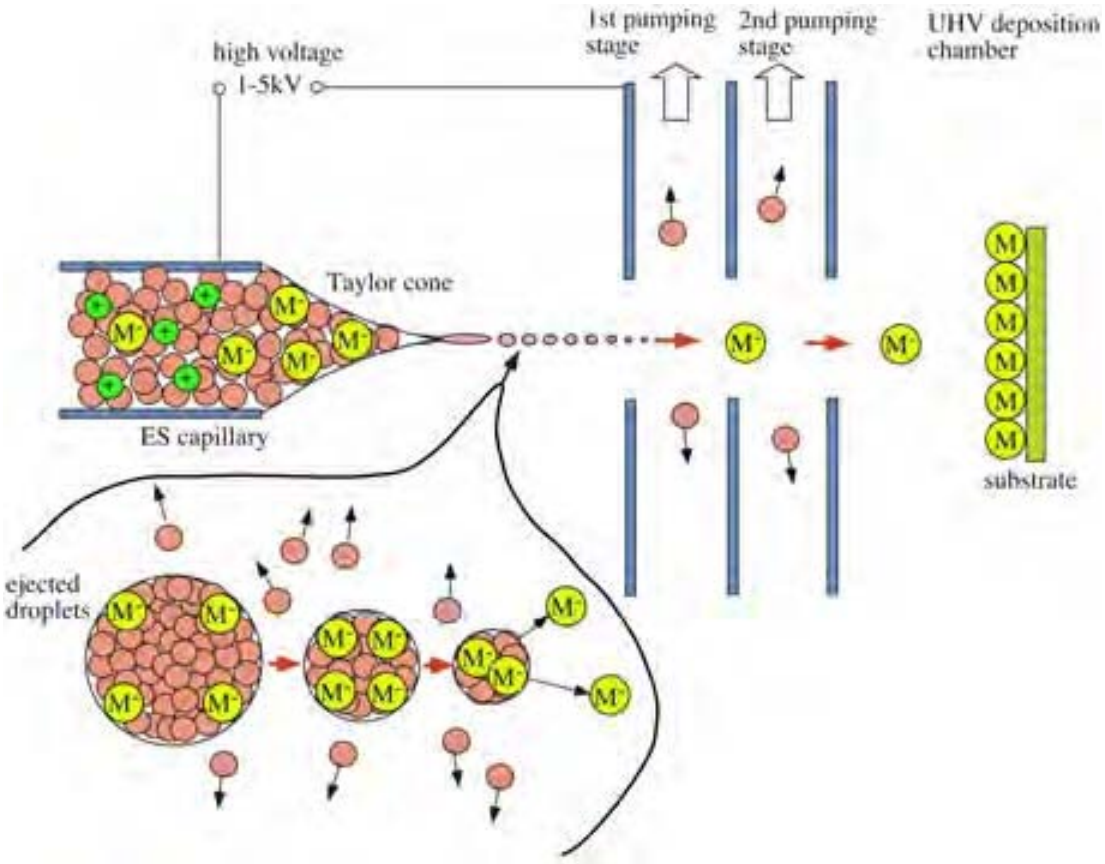
- Niquel in *Si* SEM images



D. Hernández et al. "3D metallo-dielectric structures combining electrochemical and electroplating techniques"

Outline

Moving particles with electrospray

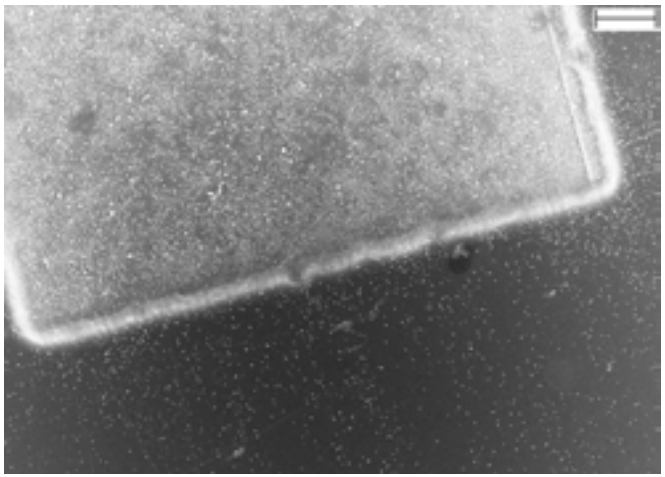


http://rsl.eng.usf.edu/Pages/ResearchElectrospray.html

Outline

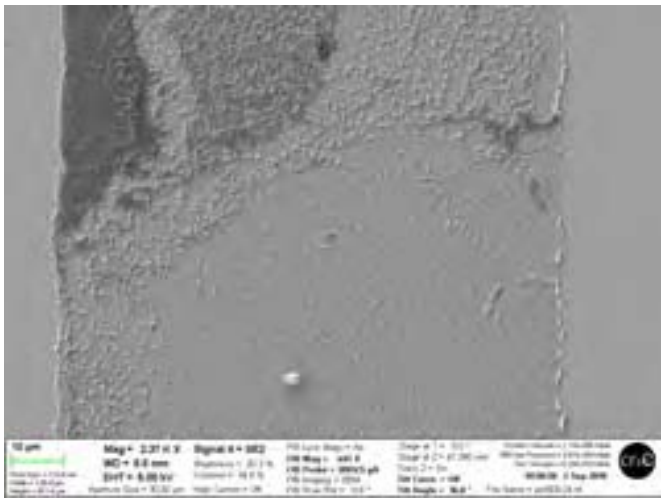
Filling of particles using electrospray

- Nanoparticles patterned in a square



Dezhi Wu et al. Pattern Deposition of Electrosprayed Polymer Nanoparticles

- Polystyrene nanoparticles patterned in a line



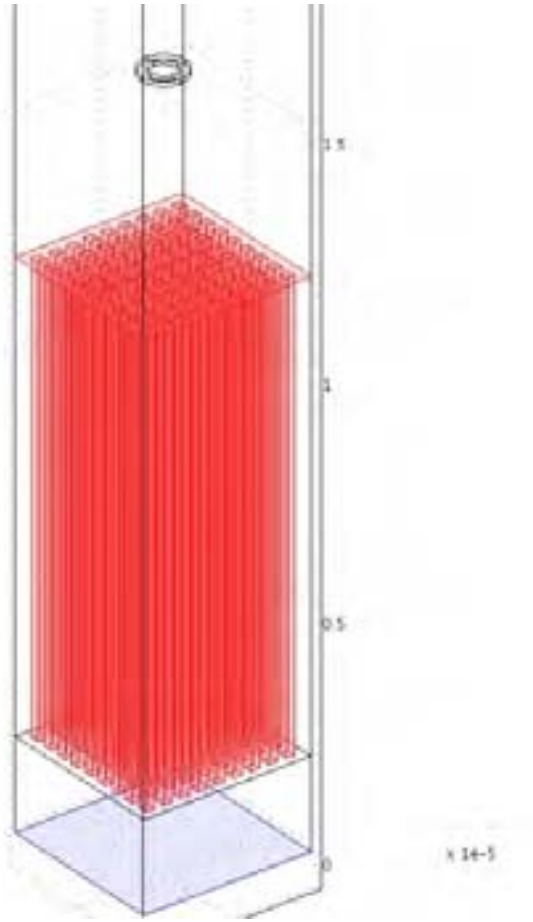
CRne Picture of a sample electrosprayed in our lab.

Outline

3D structure

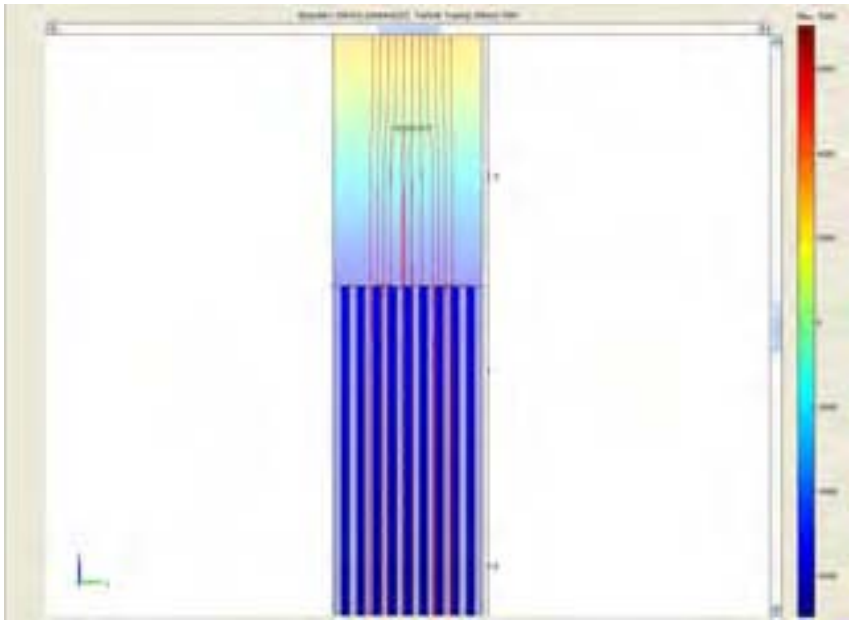
Sizes

- Height $12x10^{-5}m$
- Wide $3,8x10^{-5}m$
- Length $3,8x10^{-5}m$
- Holes:
  - Square $2x10^{-12}m^2$
  - Height $1x10^{-4}m$

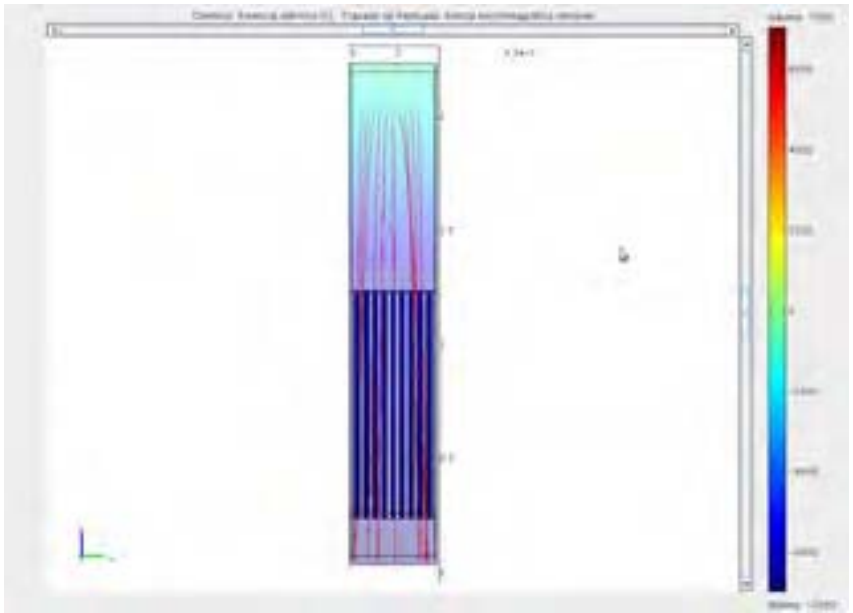


Ring effect

- Particles with ring



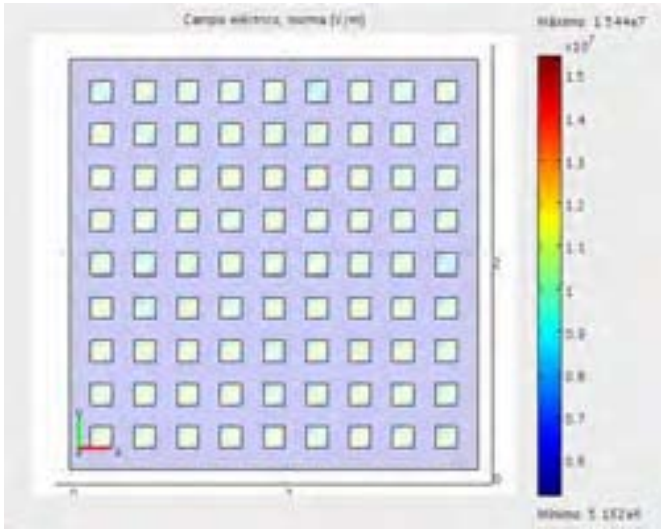
- Particles without ring



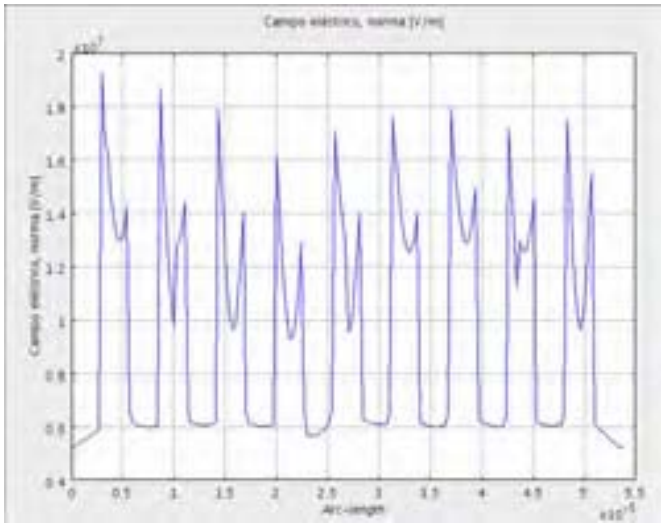
Outline

Silicon with one back contact under the photonic crystal

- Cross section at few nanometers from the top



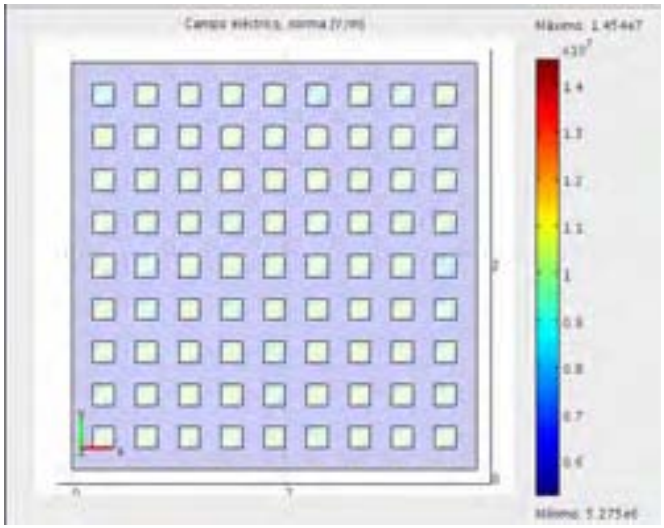
- Line crossing the holes at the same height



Outline

Silicon with contacts in each hole of the photonic crystal

- Cross section at few nanometers from the top



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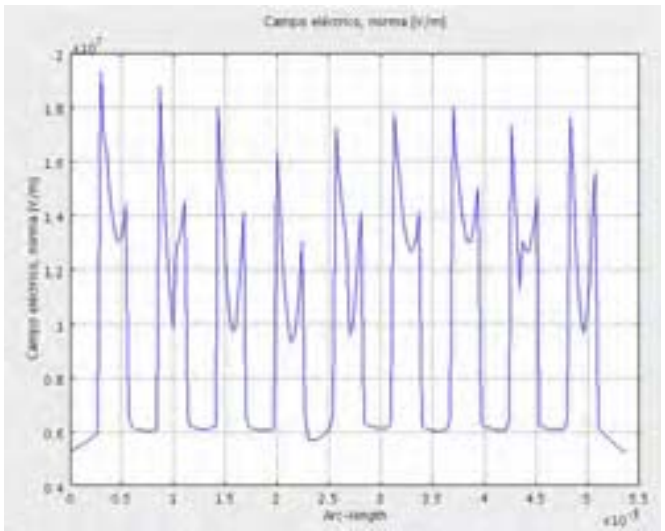
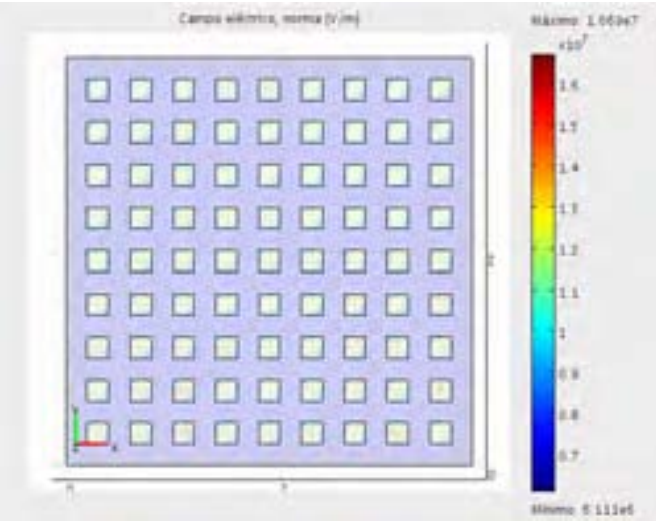


Outline

Alumina with a big back contact under the membrane

- Cross section at few nanometers from the top



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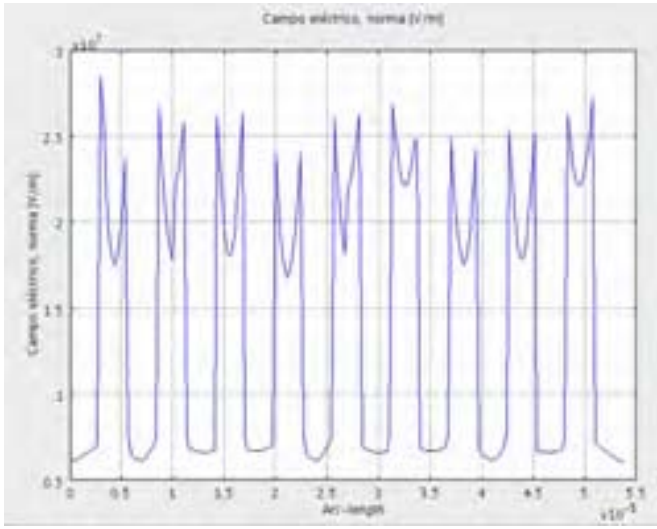
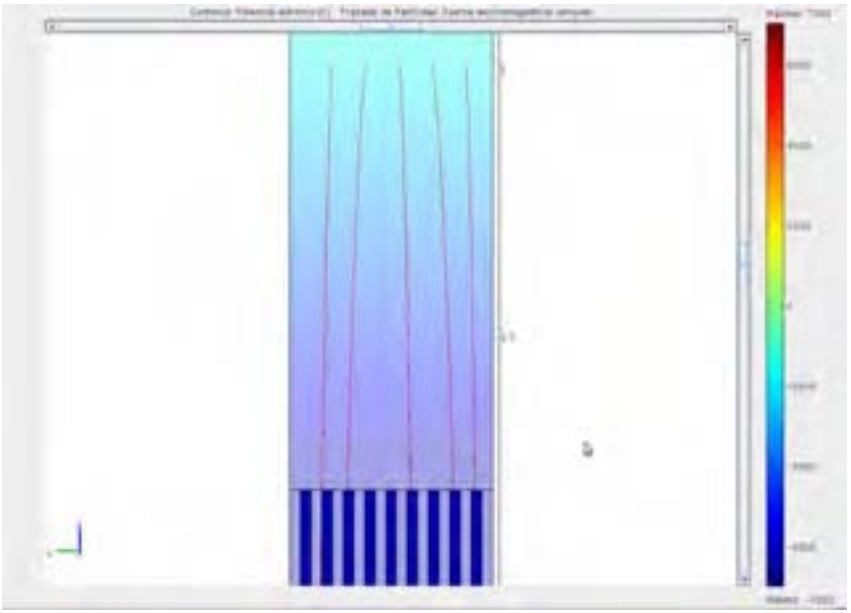
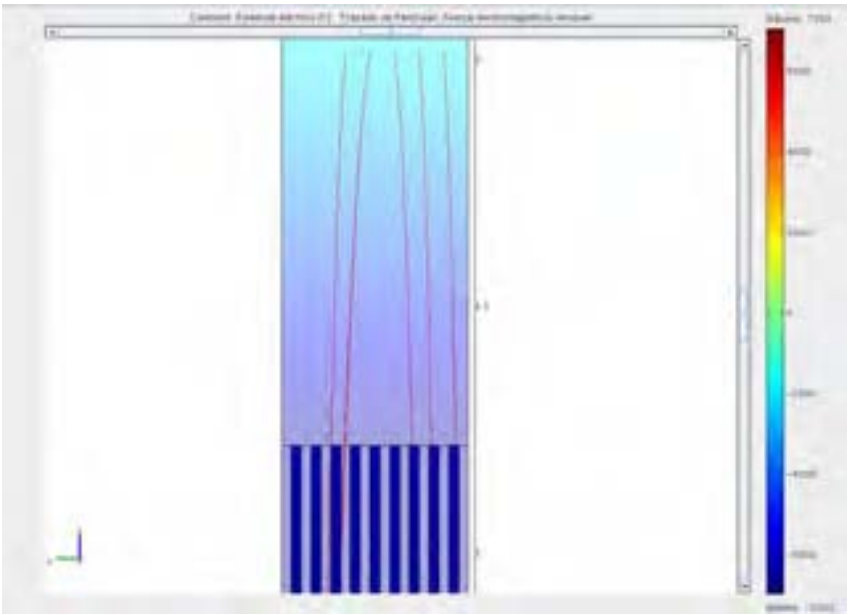


Particle tracking

- Particle tracking with silicon

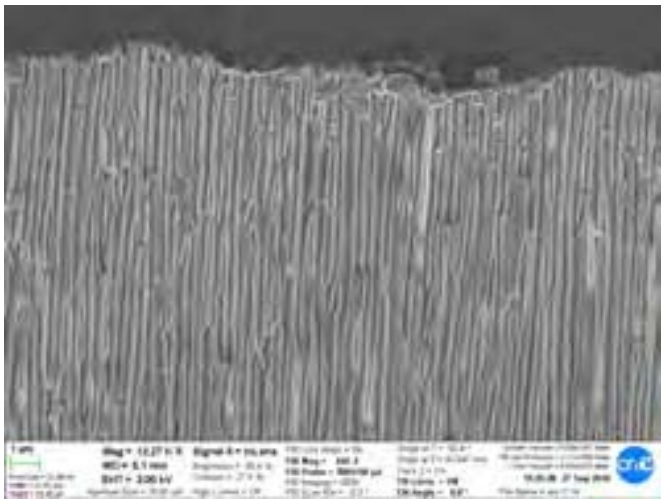


- Particle tracking with alumina



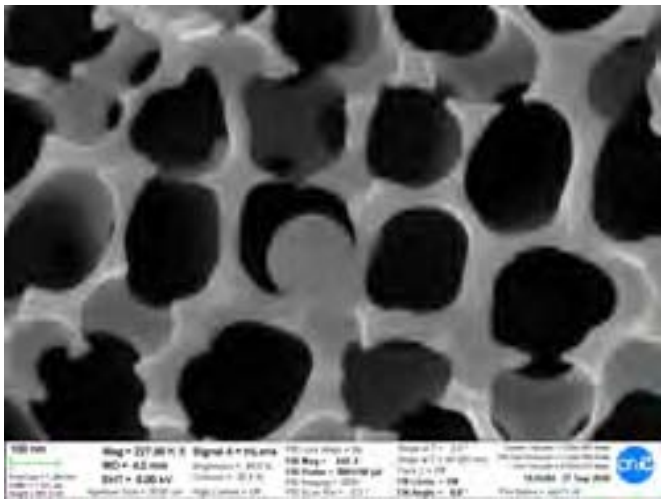
Experimental Results

- Vertical cross section of alumina



CRne Picture of a sample electrosprayed in our lab.

- Polystyrene nanoparticle inside alumina pore



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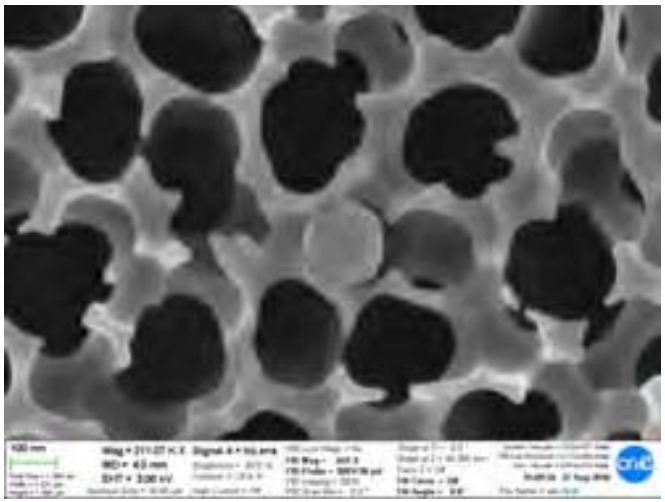

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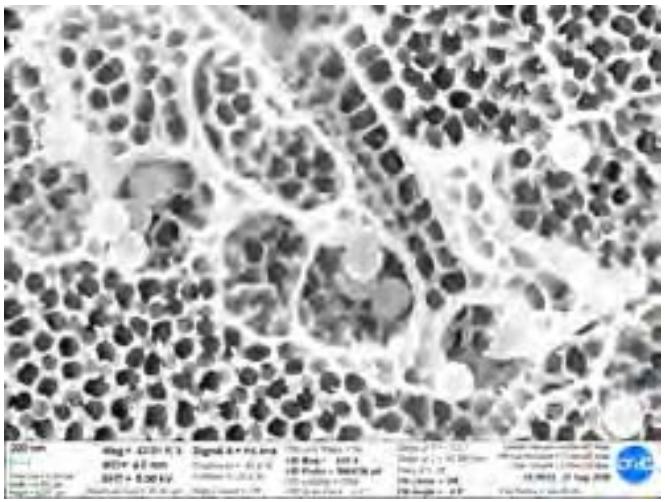

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EDS Results

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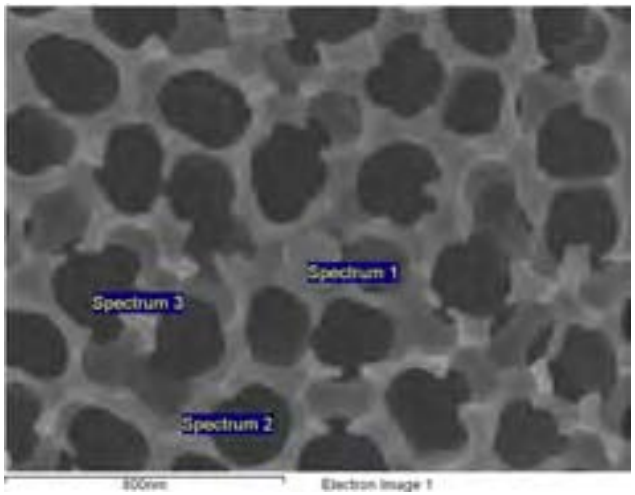

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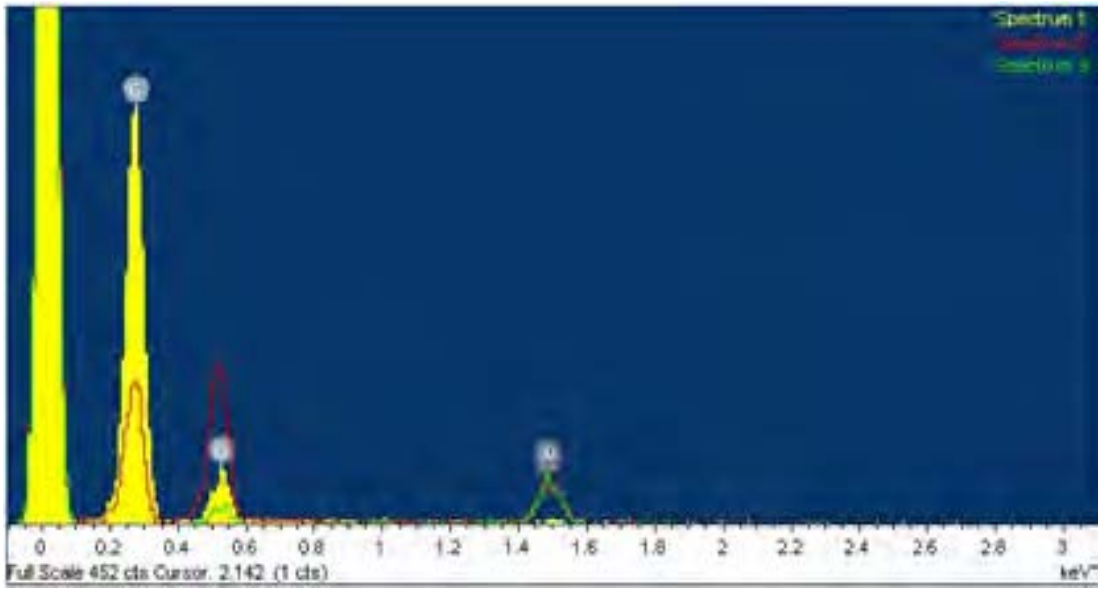
- Spectrum of materials



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Conclusion and future improvements

- Simulation is a good tool for a first approximation
- Simulation improvements
  - Including masks
  - Checking the initial conditions of the particles: charge, speed,etc.
- Physical improvements:
  - Obtain some silicon photonic crystals samples
  - Check the distribution of sizes in the nanoparticles dissolution

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Thank for your attention!!, UPC-MNT team