Identification of nanocavities water content

Maysoun Douas[1,2], Manuel. I. Marqués[1], Pedro. A. Serena[2]

[1] Departamento de Física de Materiales, Facultad de Ciencias, Universidad Autónoma de Madrid, Cantoblanco 28049 Madrid, Spain.
[2]Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas, Cantoblanco, 28049 Madrid, Spain.
maysoun.douas@uam.es

Water condensation at the nanoscale is known to play an important role in the collapse of virial capsides during desiccation [1]. The meniscus formation along with the geometry of the nanocavity allows capillary force to modify the mechanical stability towards collapse [2]. The changes on the near field optics, during the desiccation process, may be a good tool showing how this process takes place. Indeed, scan near field optical microscope (SNOM) can characterize sample composition by the changes in the optical near field. Since the virial capsides are almost transparent at optical wavelengths [3], different water contents in these nanocavities will produce different output signals distinct enough to characterize the desiccation sequence by SNOM experiments. Here we present a theoretical study in which we combine the lattice gas model to simulate water meniscus formation and a finite difference time domain (FDTD) algorithm for light propagation through the media involved. We simulate a tapered dielectric waveguide that scans, at constant height, a sample containing a virial capsides (Fig. 1). Our results show different contrasts related to different water contents (Fig. 2) and different meniscus orientations. We propose this method as a way to study water content and evaporation process in nanocavities being either biological, like virial capsides, or nonbiological like photonic crystals.

References

[1] C. Carrasco, M. Douas, R. Miranda, M. Castellanos, P.A. Serena, J.L. Carrascosa, M.G. Mateu, M.I. Marqués, and P.J.d. Pablo, Proceedings of the National Academi of Science, **106** (2009) 5475-5480.

[2] P.A. Serena, M. Douas, M.I. Marqués, C. Carrasco, P.J.d. Pablo, R. Miranda, J.L. Carrascosa, M. Castellanos, and M.G. Mateu, Physica Status Solidi C, **6** (2009) 2128-2132.

[3] W. M. Balch, J. Vaughn, J. Novotny, D. T. Drapeau, R. Vaillancourt, J. Lapierre, and A. Ashe, Limnol. Oceanogr., **45** (2000) 492-498

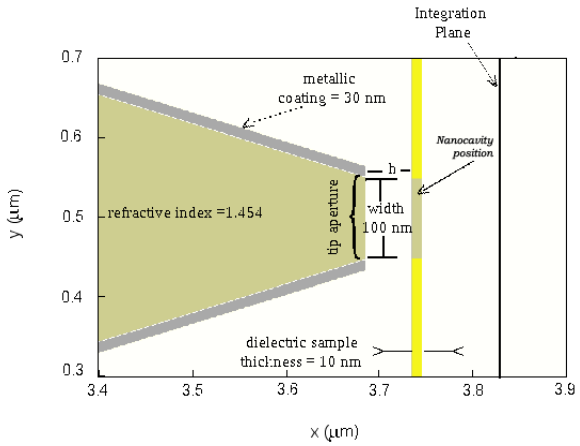

Figure 1 Schematic representation of the region of interest for the simulated tapered coated optical fiber tip. The tip is used for illuminating the region under the aperture, while transmitted signal is detected at a distance of 100 nm form the sample (Integration plane).

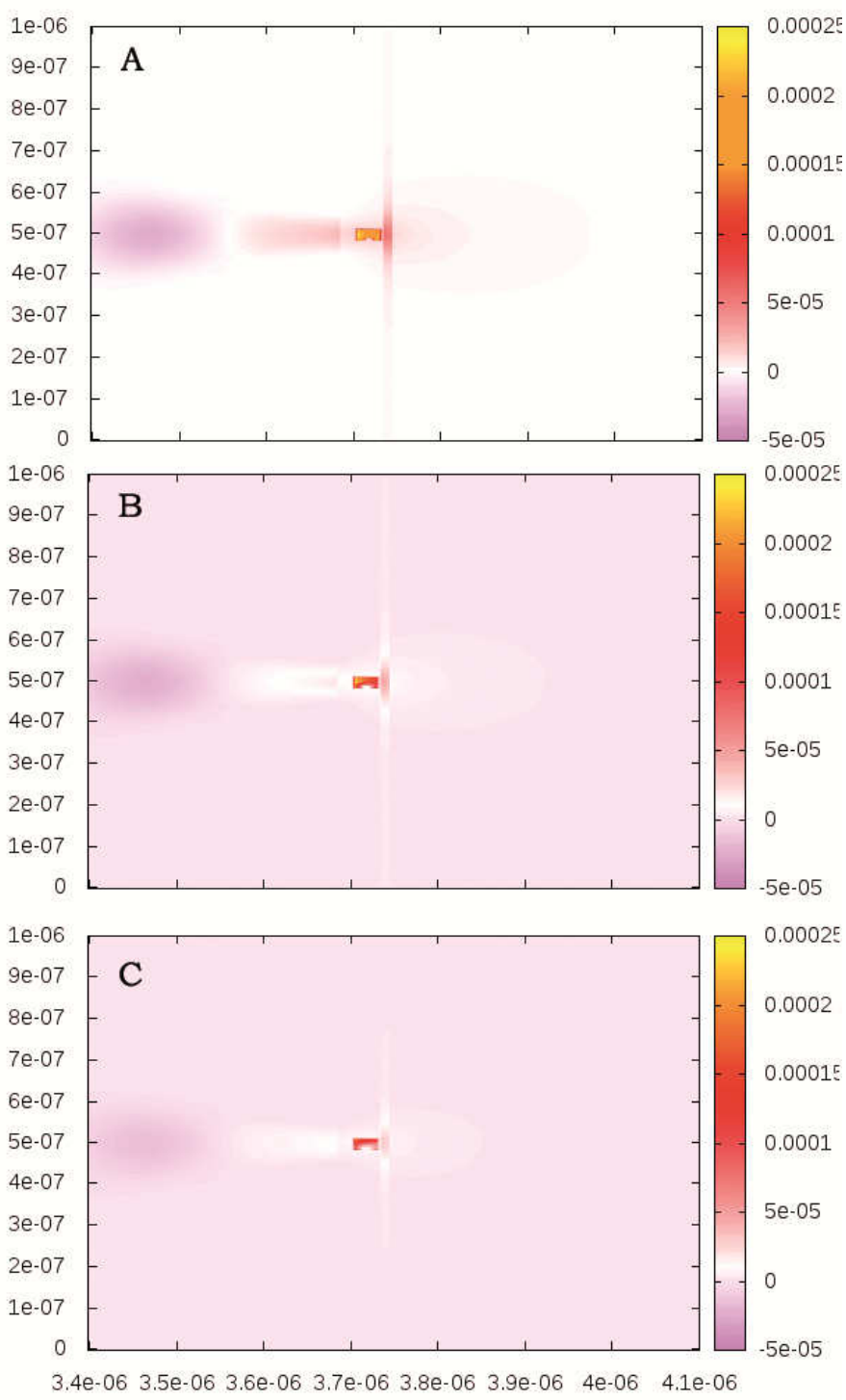

Figure 2. Optical signal intensity maps coming from the contribution of both, water content and nanocavity during the desiccation process, we have removed the signal due to the absence of virial capside, therefore both positive and negative values are present. Water occupation is100 % (A), 75% (B) and 50% (C).