Object detection with SNOM making use of humidity

Maysoun Douas, P.A.Serena, M.I.Marqués

[1]*Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas, Campus de Cantoblanco, 28049 Madrid, Spain*

[1]*Departamento de Física de Materiales, Módulo 4, Facultad de Ciencias, Universidad Autónoma de Madrid, 28049, Spain*

Maysoun.douas@icmm.csic.es

Near Field Scanning Optical Microscopy (SNOM) is a hybrid scanning probe-optical technique used for overcoming the diffraction limit of light for optical spectroscopy and high resolution marking of materials [1]. Like most scanning probe techniques, SNOM is affected by geometrical parameters and environmental conditions, such as atmospheric humidity. As hydrophilic materials attract air water molecules, it is important to understand the effect of the condensed water between probe and sample [2]. Nanometric liquid bridges may affect the shear force damping and optical signals achieved with SNOM [3-6]. For that reason, we present a simulation study using two complementary computational techniques: Finite Difference Time Domain (FDTD) calculations for light propagation [7] and Monte Carlo techniques for water condensation [8].

Thus, to show the effect of the water bridge on the optical signal achieved in the transmission mode configuration, we simulate the scan of the SNOM tip above a substrate. Furthermore, we place a hydrophilic buried dielectric inside the substrate, in order to register not only the effect of the water bridge formation but also the change in the refractive index given by the buried dielectric. Three humidity conditions were considered (Figure 1). At low humidity no bridge formation is observed. However, increasing humidity leads to the formation of the bridge between the tip and substrate when the buried dielectric is near the tip, and finally when there is enough humidity the bridge of water turns to a stable droplet during the overall measurement.

In Figure 2, we depict the intensity collected for those scan measurements depicted in Figure (1) (normalized to the case of maximum humidity) and its comparison to measurment without hydrophilic buried dielectric objects. After Figure 2, we conclude that both the presence of hydrophilic patch and atmospheric humidity affect the optical signal, opening the possibility of implementing this technique to detect water meniscus, hydrophilic regions, etc.

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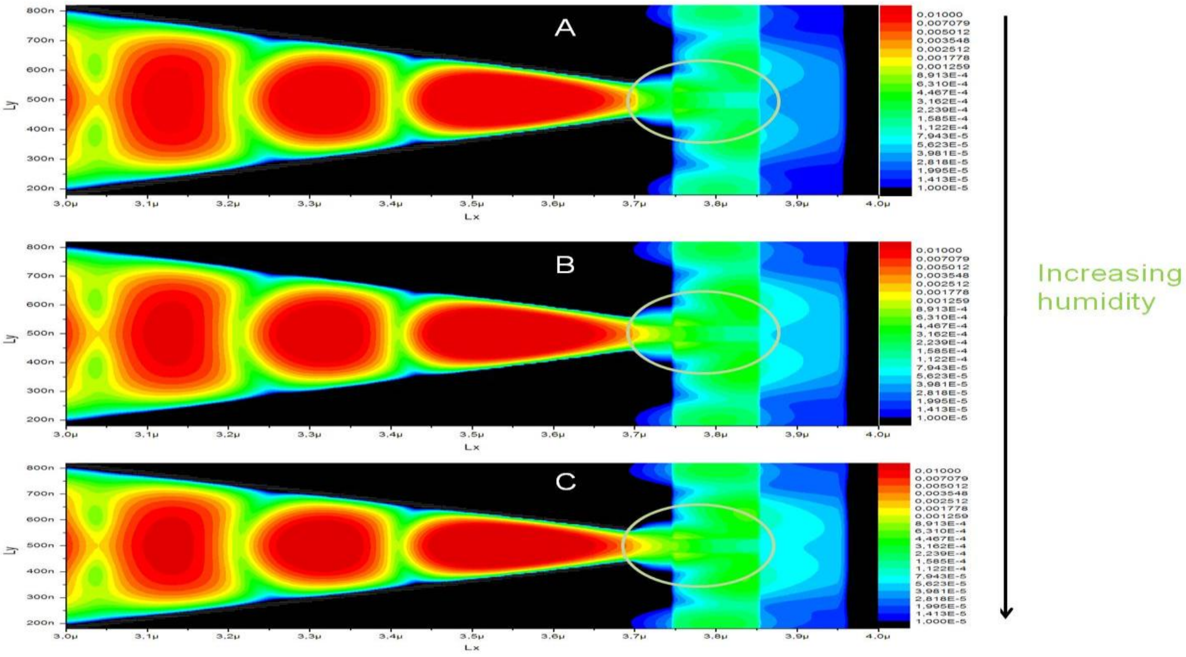

Figure 1. Intensity Color Map in logarithmic scale for the propagation of a TMz mode through the SNOM tip.

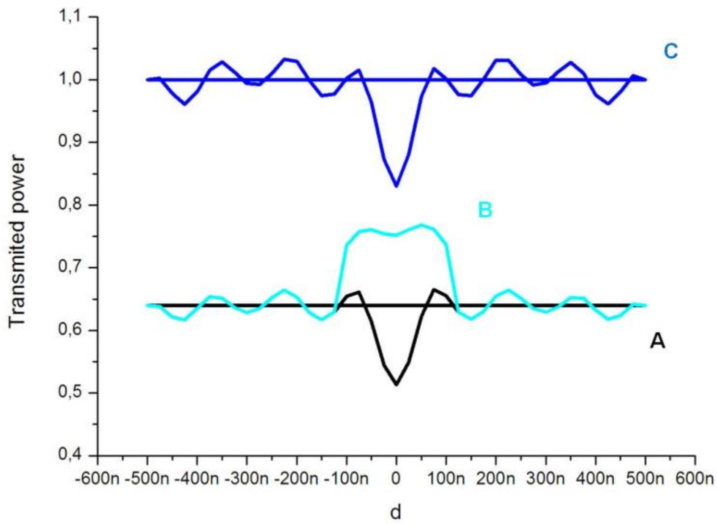

Figure 2. Normalized intensity collected for those scan measurements depicted in Figure (1) compared to measurement without object (straight lines). Liquid bridge formation clearly enhaces the amount of transmitted power (B & C).