Dielectric properties of biological samples measured at the nanoscale: from single bacteria to single viruses

G. Gomila

Institut de Bioenginyeria de Catalunya (IBEC) and Universitat de Barcelona, Baldiri I Reixac 11-15, Barcelona (Spain)

gabriel.gomila@ub.edu

Nanoscale dielectric microscopy (NDM) is a scanning probe microscopy technique that in addition to measure surface topography, enables to measure the local dielectric response (the dielectric constant, ε_r) of materials with nanoscale spatial resolution (< 50 nm). NDM can be performed in both AC current-sensing or force-detection mode, and in recent years it has become a well applied technique for the study of dielectric materials [1-3]. Besides its application in materials science, it enables also to quantify the dielectric properties of biological samples and hence to quantitatively investigate electrostatic phenomena in biology. In the present communication, we will introduce nanoscale dielectric microscopy and present recent results obtained in the study of a variety of biological systems ranging from single viruses [4] and single bacteria to supported biomembranes [5]. In particular, we will show that the quantitative nature of the technique enables to develop a novel label-free material identification method based on the measurement of the dielectric response of the samples [4]. Examples include the identification of dielectric nanoparticles of different material composition [4], of single viruses from its empty capsids [4] or of single bacteria of different types. Finally, we will show how this technique can be extended to the liquid environment [6,7] opening a number of important possibilities in the study of electric processes in small scale biological systems.

References

[1] Fumagalli, L., Ferrari, G., Sampietro, M. and Gomila, G. Appl. Phys. Lett. 91, 243110 (2007).

[2] Gramse, G., Casuso, I., Toset, J., Fumagalli, L. and Gomila, G,. Nanotechnology 20, 395702 (2009).

[3] Fumagalli, L., Gramse, G., Esteban-Ferrer, D., Edwards, M. A. and Gomila, G., Appl. Phys. Lett. 96, 183107 (2010).

[4] Fumagalli, L., Esteban Ferrer, D., Cuervo, A., Carrascosa, J. and Gomila, G., Nature Materials, 11, 808–816 (2012).

[5] Fumagalli, L., Ferrari, G., Sampietro, M. and Gomila, G., Nano Lett. 9, 1604-1608 (2009).

[6] Gramse, G., Edwards, M., Fumagalli, L. and Gomila, G., Appl. Phys. Lett., 101, 213108 (2012).

[7] Gramse, G., Dols-Pérez, A., Edwards, M., Fumagalli, L. and Gomila, G., Biophysical Journal, 104, 1257-1262 (2013).