The interplay between pore size and wettability in solid-templated silica films

Luca Rimoldi[a,b,*], *Valentina Pifferi*[a,b], *Francesco Segrado*[a], *Guido Soliveri*[c], *Luigi Falciola*[a,b], *Silvia Ardizzone*[a,b], *Daniela Meroni*[a,b]

[a] Dpt. Chemistry, Università degli Studi di Milano, via Golgi 19 20133 Milano, Italy
[b] Consorzio INSTM, via Giusti 9 50121 Firenze, Italy
[c] Polytechnique Montréal, Department of Engineering Physics, H3T 1J4 Montréal, Canada.

*luca.rimoldi@unimi.it

In recent years, the attention to templated SiO_2 nanomaterials is particularly focused to film structures, for several different applications. Beside the use of MCM-41 mesoporous silica types, solid templating agents such as polystyrene (PS) latex have been adopted in order to create a morphologically different porosity network, characterized no more by cylindrical pores, but by spherical and possibly interconnected cavities.

In the present work, a silica sol was prepared and deposited on conductive glass in a mixture with a PS latex suspension. A careful adjustment of the preparation procedure was conducted and allowed stable, reproducible and electrochemically performing mesoporous thin films to be synthesized. Especially, the sol composition, the controlled ageing procedure, the right template to silica precursor ratio and the deposition procedure parameters revealed to be pivotal for the obtainment of homogeneous and transparent silica thin films. In this context, the physicochemical properties of the films as well as the SiO_2 sol were studied. For example, Dynamic Light Scattering (DLS) analyses allowed the dimensions of the silica nuclei promoting the obtainment of the deposited layers to be quantified as a function of the sol ageing.

Both the number of successive deposited layers and the dimension of the template (30, 60, 100 nm) were varied. In this sense, aspects pertaining the morphological features of the silica films were deeply characterized by FE-SEM and AFM analyses. Multi-layered depositions allowed an interconnected porous structure to be created, while the influence of the template diameter affected not only the morphology of the film, but above all the diffusion properties of electrochemically active species to the conductive surface of the substrate. In this regard, the electrochemical properties of the prepared devices were compared to thin films in which no templating agent was adopted, revealing large differences both by Cyclic Voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS). Electrochemical results were also interpreted in the light of water contact angle measurements. The wettability of the samples surface revealed to be a crucial parameter for the sensing properties of the films and was found to be in complete agreement with roughness data provided by AFM measurements, according to the Wenzel model. Moreover, the study of the optical properties by UV-vis transmittance spectroscopy revealed nonreflective properties with respect to the pristine substrate, thus opening the path to other possible applications, *e.g.* in the field of optical devices.