**Josep Ferré-Borrull,** Elisabet Xifré-Pérez, Chris Eckstein, Josep Pallarès and Lluis F. Marsal
Universitat Rovira i Virgili, Av. Paisos Catalans 26, 43007 , Tarragona, Spain
lluis.marsal@urv.cat

# Optical monitoring of surface modifications in nanoporous materials

Nanoporous materials such as porous silicon (pSi) and nanoporous anodic alumina (NAA) are increasing their interest as enabling platforms for biotechnology (Figure 1). Such materials are obtained from the electrochemical etching in acidic electrolytes of bulk silicon or aluminum, respectively. Preparation methods are at present well-known, cost-effective and easily scalable[1]. In the application of such materials to biotechnologies, one crucial step is functionalization: modification of the pore surface properties in order to provide the appropriate functions. Such surface modification is achieved by the attachment of different molecules such as silane self-assembled monolayers (SAM), proteins or aptamers and has enabled applications in fields such as sensing, drug delivery or tissue engineering[2,3].

In this work we study different surface modification paths for pSi and NAA with different methods. Besides the usual SEM characterization, nanometric pores require other strategies to evaluate the amount of attached species on their walls. We apply optical methods for such evaluation: the reflection intereference spefctroscopy (RIfS)[4] and the fluid imbibition-coupled laser interferometry (FICLI)[5]. In RIfS, the reflectance spectra of thin films of porous materials are measured before and after the surface modification (Figure 2) and the change in effective optical thickness (EOT) of the thin film can be related to the change in surface structure. On the other hand, in FICLI, the infiltration of a liquid in a porous material is monitored in real time and the filling dynamics are related to the structure and surface properties (Figure 3). The work will report the latest results obtained with these two methods on both kinds of material and for different attached SAMs and proteins.

## References

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[3] Baranowska M. et al., Journal of Colloid and Interface Science, 452 (2015) 180.
[4] Macias, G. et al., Analyst, 140 (2015) 4848.
[5] Eckstein, C. et al., Langmuir, 32 (2016), 10467.

## Acknowledgements

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## Figures

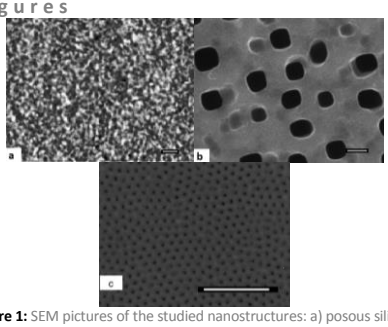


**Figure 1:** SEM pictures of the studied nanostructures: a) posous silicon, b) macroporous silicon and c) nanoporous anodic alumina. The bars are 1 micron.

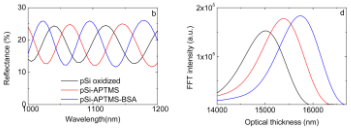


**Figure 2:** RIfS spectra of Psi After different surface modifications (left) and corresponding Fourier transform where the maximum corresponds to the EOT (right).

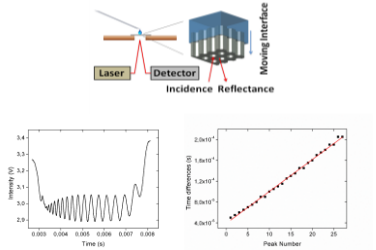


**Figure 3:** (Top) schematic drawing of the FICLI method to determine pore geometry and surface properties. (Bottom left) example of tiume-resolve interferogram obtained by the method and (bottom right)analysis of the interferogram.