Mesoporous thin films: exploiting new nanospace features for electrochemical and optical sensing

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Mesoporous materials with high surface area and highly controlled mesopore diameter (2-50 nm) constitute highly tunable nanoarchitectures. The pore symmetry and surface can be finely tailored, and "decorated" with molecular, bioactive or nanoscale functions. The possibility of combining chemical synthesis, self-assembly and orthogonal surface reactions gives us a broad palette for creating exciting multiscale nanomaterials that mimic the complexity of those found in Nature.

Mesoporous thin films (MTF) provide an exciting avenue in the fields of advanced sensing and energy, by fully exploiting their architectures, functional positioning, surface processes and nanofluidics. Current synthetic and production strategies permit to easily and reproducibly prepare optical quality thin films, electrodes or photonic crystals on a variety of substrates, which makes them useful as optical or electrochemical sensors.

MTF offer a variety of sensing possibilities through molecular sieving, selective electrostatic or steric exclusion and preconcentration effects, which are a consequence of mesopore confinement and surface functionalization. Mesoporosity is an advantage for improved transport properties, tunable charge management and optical responsivity. Plus, the synthetic methods are fully compatible with processes taking place in electronics and optics industry, making MTF an interesting platform for future integrated optical and electrochemical nose devices.

We will present examples of MTF rational design and production aiming at applications in selective electrochemical and optical sensing. We will give examples on how the combination and feedback of synthesis, characterization and modeling leads to pre-designed functional electrodes or optical devices such as responsive photonic crystals, in which the final properties are programmed in their structure at several length scales and interfaces. We will demonstrate the possibilities of designing and building novel sensing devices based in nano-enabled processes such as perm-selectivity, selective condensation or confined bioaffinity. The only limit is imagination.