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Supercritical Fluid Deposition of silanes on solid surface for biosensing and heterogeneous catalysis applications

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Nowadays, chemistry plays an important role at the interface between organic or inorganic substrates and chemical or biological environment to develop hybrid micro- and nanosystems. Thus, there is a great need to chemically tune the properties of a material into a function such as sample conditioning, production, separation, recognition and detection of species. Since 15 years, we are continuously developing a chemistry "tool box", which is focused on the creation of a chemical interface and designed for integrated systems by taking into account the fabrication and applications constraints [1].

Recently, we have developed low environmental impact processes using molecular vapor deposition of silane for localized biofunctionalization of chemically modified nanopores for label-free detection [2]. The molecular vapor deposition displays several environmental advantages including the prevention of wastes, the requirement of less energy, while avoiding the handling of chemical products and minimizing the potential for chemical accidents. But, MVD process implies the vaporization of the organic molecules restricting the applications. Thus, the deposition of poorly vaporizable or temperature sensitive molecules is problematic. Therefore, we have studied the deposition of molecules on supercritical carbon dioxide ($scCO_2$) for its remarkable properties: density close to solvents, zero surface tension, low viscosity and high diffusivity. $ScCO_2$ easily diffuses into porous materials and micro- and nanostructured devices. Due to its low price, its non-toxicity and its non-flammability, this solvent is very attractive for the production of microdevices and their surface treatment. We have demonstrated, for the first time, the deposition of 3,4-epoxybutyltrimethoxysilane on silicon oxide using $scCO_2$ deposition [3]. This functional scaffold opens new possibilities, such as supported and recoverable catalysts.

Our chemistry "tool box" is thus expanding towards greener processes and broader applications such as environment, wellness, medicine, energy, information and space. We are continuously developing innovative solutions for plastic (cyclic olefin copolymer…) and biomaterials (nanocellulose…) surface functionalization that will be compatible with production methods while providing new properties or smart coatings.

References

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