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Highly porous based nanocomposites designed for ultrasensitive detection of environmental pollutants

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Aerogels are highly porous materials with a low density, large open pores, and a high inner surface area produced via sol-gel process followed by supercritical drying. Their unique morphological characteristics like pore volume, pore size distribution and connectivity, make them suitable for sensor applications. Our research activity in the last period was focused on designing such unique porous structures for improving their capability for ultrasensitive detection of environmental pollutants. In this respect, the first approach consisted in designing TiO_2 aerogel-Au/Ag nanoparticles based materials for efficient detection by using Surface-Enhanced Raman Scattering (SERS), taking into consideration the great enhancement of the Raman signal that occurs after positioning a pollutant molecule on Au/Ag nanoscale-roughed surfaces, or in their proximity. The greatest performances related to the mentioned functionalities were acquired for the porous composites obtained by impregnating the titania gel with Au/Ag nanoparticles followed by supercritical drying, and the lowest detectable concentrations by SERS varied between 10^{-2} and 10^{-10} M, depending on the synthesis method, pollutant species and the excitation type, i.e., off and under resonant condition. The second approach is related to the obtaining of electrodes based on Bi doped carbon aerogels and xerogels, incorporated in a matrix of chitosan, and deposited on glassy carbon, for the ultrasensitive voltammetric detection of heavy metals like Pb(II) and Cd(II), and pharmaceuticals compounds. For this approach the detection limits were found to be between 10^{-8} and 10^{-13} M, depending on the pollutant type.

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Odor biosensors based on organic semiconductors towards low-cost health care diagnosis in gynecological diseases

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In the past decades, we have seen a big development in sensor technology, which changed completely the way we interact with electronic devices and consequently our lifestyles. A promising application of sensors is in the area of medicine. Some biosensors can be able to detect and distinguish analytes for specific diseases. One of these types of devices are electronic noses. New e-noses were designed and developed in order to fulfill medical devices standards. Conductive polymer properties make them a good choice for cost effective and transportable e-noses. Although there are already a couple of commercial e-noses based on conductive polymers, they still have a big cost associated, and there is still a big research to improve their performance, considering the exigencies for medical devices. In this work, e-nose biosensors based on nanostructured PEDOT:PSS thin films as sensing material, in a carbon interdigitated electrodes configuration, was made and characterized. The focus was the detection of the two most important gynecological diseases, the Candidiasis and Lactobacillus. The sensors were made in low cost/high output systems, namely screen-printing and Roll-to-Roll process. The results, obtained by resistive and capacitive responses, allows, in a simple way, distinguish the normal and infected analytes for both diseases. Different sensor geometries was studied. The obtained data that can be easily processed, associated with the production technologies, opens a new framework in the wide spreading of health care/home care diagnosis.

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