

# TiO<sub>2</sub>NPs-AgNPs hybrids: synthesis and characterization of tailored nanosystems for gas sensors applications

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The detection of toxic gases in the environment, *i.e.*, BTX (benzene, toluene, p-xylene) or H<sub>2</sub>S is of the utmost importance for human health. Solid-state sensors which can adsorb and monitor gas molecules on a solid surface of highly sensitive materials are very useful sensing components. Thus, the aim of this work is to design a new nanohybrid system by direct conjugation of titania nanoparticles with a size of 40 nm, with *in situ* prepared silver nanoparticles (TiO<sub>2</sub>NPs-AgNPs) as solid-state sensor for the adsorption of toxic gases. For this conjugation process, the first step is related to the surface functionalisation of TiO<sub>2</sub>NPs, using the covalent linker 3-(mercaptopropyl)trimethoxysilane (MPTMS). It is noteworthy that MPTMS is a bifunctional alkoxysilane linker that provides terminal -SH groups suitable for attaching Ag surface. After quantification of the amount of free -SH groups on the surface of TiO<sub>2</sub>NPs, using a rhodamine-based dye, Ag<sup>+</sup> precursor was allowed to react with sodium borohydride as reducing agent, in the presence of the functionalized TiO<sub>2</sub>NPs and hydrophilic thiol 3MPS (3-mercapto-1-propanesulfonate). With this approach, hydrophilic TiO<sub>2</sub>NPs-AgNPs were prepared with different content of AgNPs decorating TiO<sub>2</sub>NPs surface. Extensive characterizations, including UV-Vis, ATR, XPS, ICP-OES, FESEM-EDX, DLS and ζ-potential were used to characterize the as-synthesized hybrids in terms of optical and structural features, stability, size, morphology and chemical composition. These results demonstrated the successful silanization of TiO<sub>2</sub>NPs and subsequent *in situ* AgNPs-3MPS decoration. In addition, nanohybrid samples were deposited as thin films on interdigitated electrodes to investigate their resistive response against H<sub>2</sub>S and relative humidity at room temperature. A tuning of the resistive response was found by varying the Ag content, with photoactivated process. A reversible response was found with good sensitivity to H<sub>2</sub>S content, in the range 0-40 ppm.