Detection of VOCs Traces by Graphene Oxide-Metal Oxide Gas Sensors

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The sensing of gas molecules is of fundamental importance for environmental monitoring, control of chemical processes, medical applications, and so on [1-3]. In recent years, graphene-based gas sensors have attracted much attention due to enhanced graphene thermo-electric conductivity, surface area and mechanical strength. Thus, different structures have been developed and high sensing performances and room temperature working conditions were achieved [2,4]. However, they still suffer from several problems, which could be overcome by covering the graphene surface with metal oxide nanoparticles [2]. Furthermore, studies regarding the detection of Volatile Organic Compounds (VOCs) are still at the beginning [3]. Hence, the present work will be aimed at: *i*) optimizing the synthetic routes of *ad hoc* composite VOCs sensing materials (based on graphene oxide/SnO_2 or ZnO hybrids) and their deep physico-chemical characterizations; *ii)* engineering the gas sensor device; and *iii*) evaluating the sensing performances at both high and mild temperatures (also exploiting the UV light) towards gaseous ethanol, acetone and ethylbenzene.

Starting from pure graphite, graphene oxide (GO) powder was synthesized by adopting the Hummer's modified method [5]. The synthetic route was deeply investigated by modulating both the starting carbon material (powder or flakes graphite) and the concentration of the H_2O_2 (*i.e.* the quenching/oxidizing agent), thus tailoring the final GO surface/structural properties (TEM images in Fig. 1a and 1b). Once optimized this step, SnO_2 or ZnO were grown on its surface by a hydrothermal method, varying the starting salt precursor/GO weight ratio between 4 and 32 (Fig. 1c and 1d). For comparison, pure SnO_2 and ZnO (both commercial and home-made) were also tested. Several physico-chemical techniques have been used to characterize all the as-prepared nanopowders, such as XRPD, Raman, FTIR, XPS and TEM analyses. Subsequently, a homogeneous layer was deposited by spraying technique onto Pt-Interdigitated Electrodes (IDEs) starting from an ethanol suspension of each sample (2.0–2.5 mg mL^{-1}). Then, gaseous ethanol, acetone and the less studied ethylbenzene were sensed, obtaining very promising results (in terms of both response/recovery time and sensibility down to ppb levels) for either pure and hybrid materials at 350°C, and at lower temperatures (150°C to 30°C) for the graphene-based samples. Hence, these powders may represent very potential candidates for the gas sensing of highly toxic VOCs traces, both for environmental [1] and medical [3] diagnosis purposes.
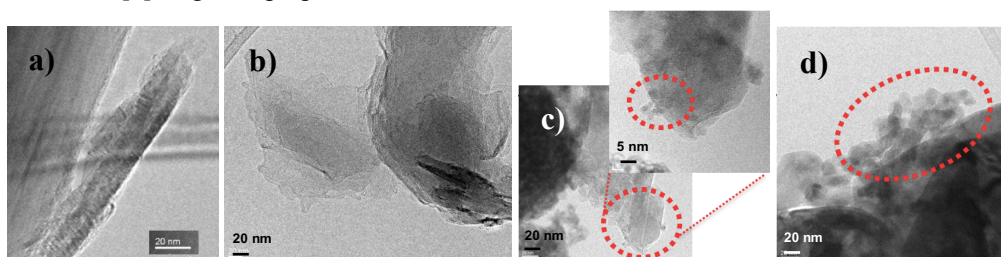

Figure 1. TEM images of **a)** pure graphite, **b)** GO, **c)** SnO_2@GO (inset: magnification), **d)** ZnO@GO.

References
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