Low Temperature Composite Sensors for Environmental and Medical Applications

E. Pargoletti,[a,b] A. Tricoli,[c] M. Longhi,[a,b] V. Guglielmi,[a,b] G. Cappelletti,[a,b]
[a] Dipartimento di Chimica, Università degli Studi di Milano, via Golgi 19, 20133, Milano, Italy
[b] Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali (INSTM), Via Giusti 9, 50121, Firenze, Italy
[c] Nanotechnology Research Laboratory, Research School of Engineering, Australian National University, Canberra 2601, Australia
eleonora.pargoletti@unimi.it

The sensing of gas molecules is of fundamental importance for environmental monitoring, control of chemical processes, medical applications, and so on [1]. 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]. However, they still suffer from several problems, which could be overcome by covering the graphene surface with metal oxide nanoparticles. 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); *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. 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. Once optimized this step, SnO_2 or ZnO were grown on its surface by hydrothermal method, varying the starting salt precursor/GO weight ratio between 4 and 32. 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. Subsequently, a homogeneous layer was deposited by spraying technique onto Pt-Interdigitated Electrodes (Pt-IDEs) starting from an ethanol suspension of each sample (2.5 mg mL^{-1}, Figure 1). Then, gaseous ethanol, acetone and 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.

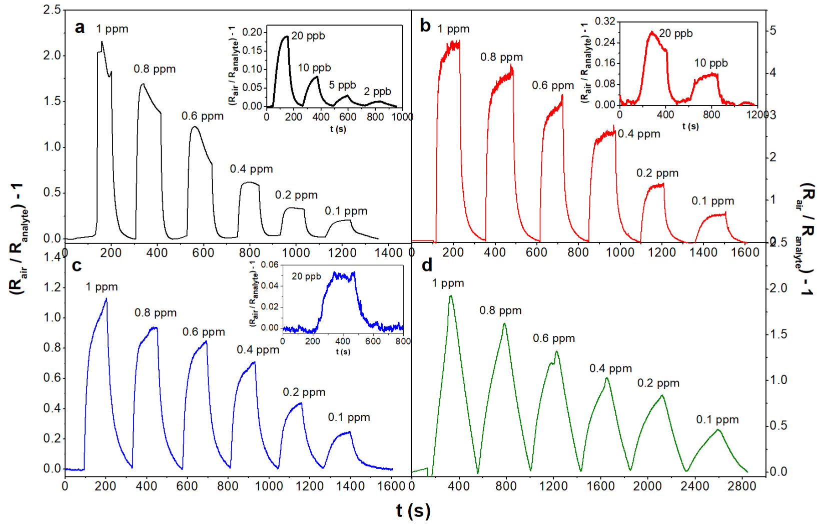

Figure 1. Ethanol sensor response obtained by **a)** pure home-made SnO_2 at 350°C (no UV), and SnO_2-GO 32:1 at **b)** 350°C (no UV), **c)** 150°C (with UV), and **d)** RT (with UV).

References

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[3] J. Chen, *et al.*, Carbon, 64 (2013) 225–229.