CHEMIRESISTIVE DEVICES BASED ON GRAPHENE DECORATED WITH METAL OXIDE NANOPARTICLES FOR NO2 DETECTION

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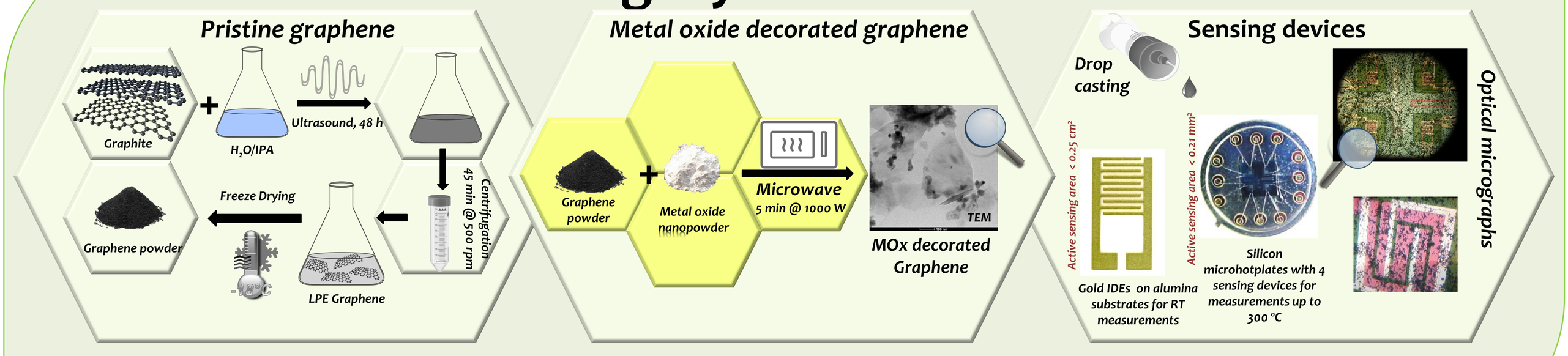
We present the sensing performances upon exposure to nitrogen dioxide of chemiresistors based on graphene, functionalized with several metal oxide NPs. Four types of sensors were analyzed: pristine graphene (Gr), ZnO doped graphene (GZnO), SnO2 doped graphene (GSnO2) and TiO2 doped graphene (GTiO2) sensors. The preparation of metal oxide NP doped graphene was performed by first freeze drying of graphene suspension previously prepared by liquid phase exfoliation method. The obtained graphene powders were mixed with metal oxide NP (3:1 mol/mol) and finally microwave irradiated for 5 minutes at 1000 W. The materials were characterized by SEM, TEM and Raman spectroscopy. Solutions of these powders in ethanol and isopropyl alcohol/water were deposited by drop casting onto two types of substrates: alumina substrates for room temperature measurements and silicon microhotplates for measurements up to 300 °C. The sensors were characterized in an automated gas line.

Sensing layers fabrication

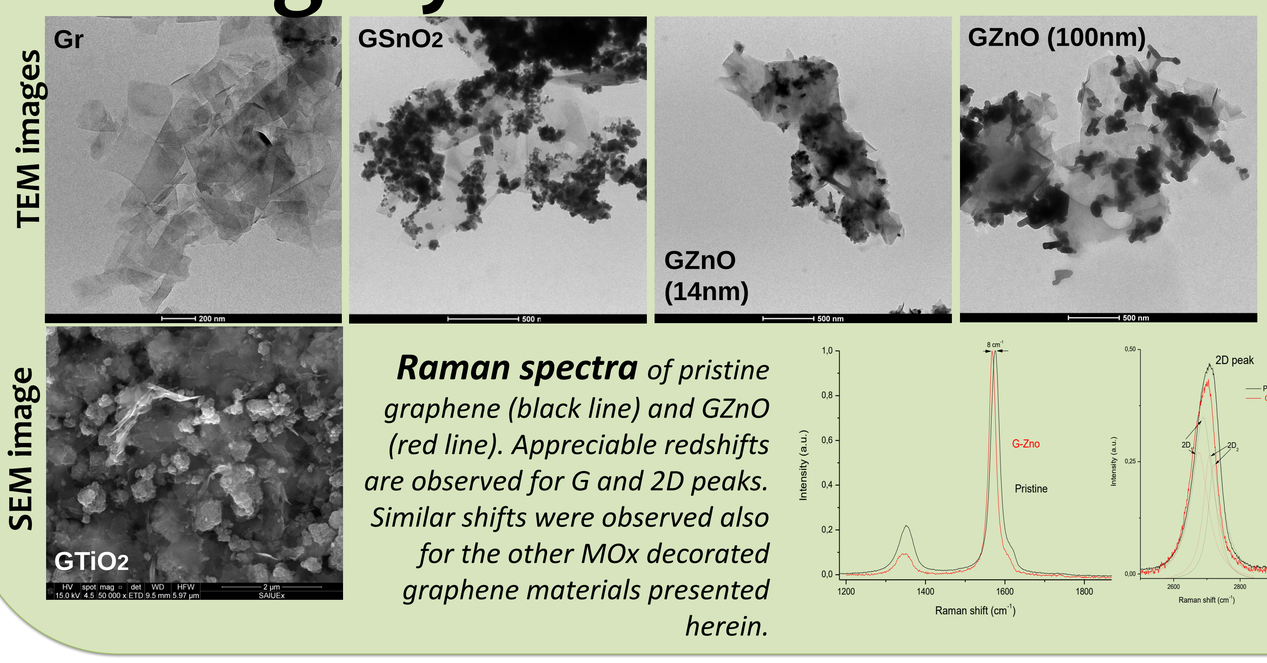


*Graphite flakes were dispersed into a mixture of ultrapure water and i-propanol and sonicated. Unexfoliated graphite crystallites were removed by centrifuging. The **concentration of the graphene** suspension was **0.1 ± 0.1 mg ml^{-1}***

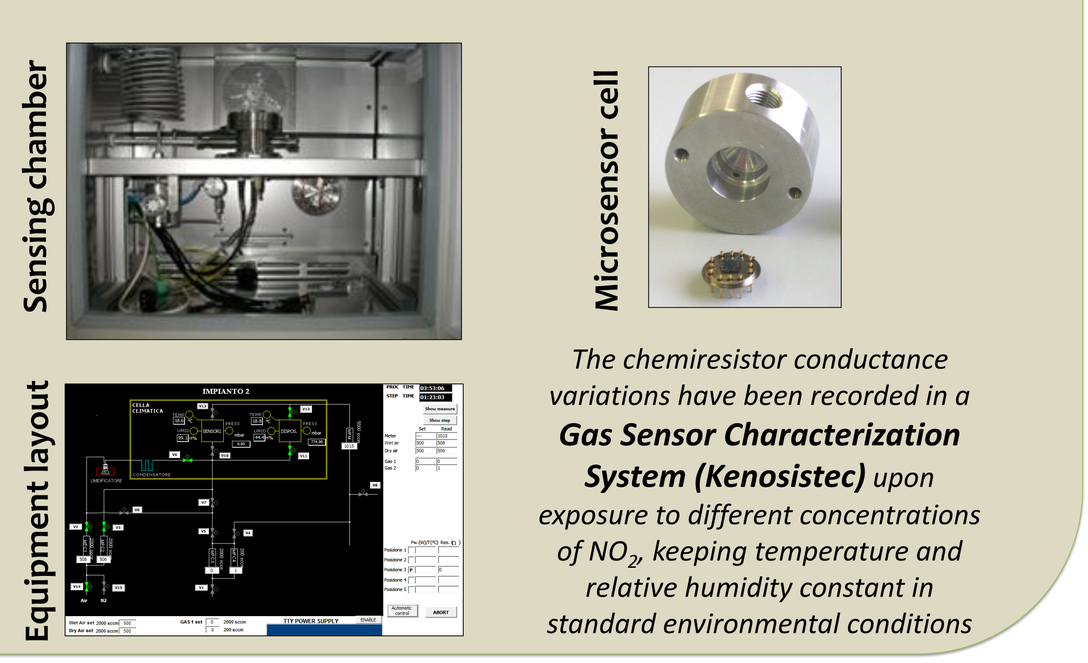
Graphene powder was obtained by freeze drying of graphene suspension. 2.5 mg of graphene powder was mixed with 4 mg of metal oxide and microwave irradiated for 5 minutes at 1000 W

The resulting powder was dissolved in ethanol and isopropyl alcohol/water mixture and deposited by drop casting onto two types of transducers

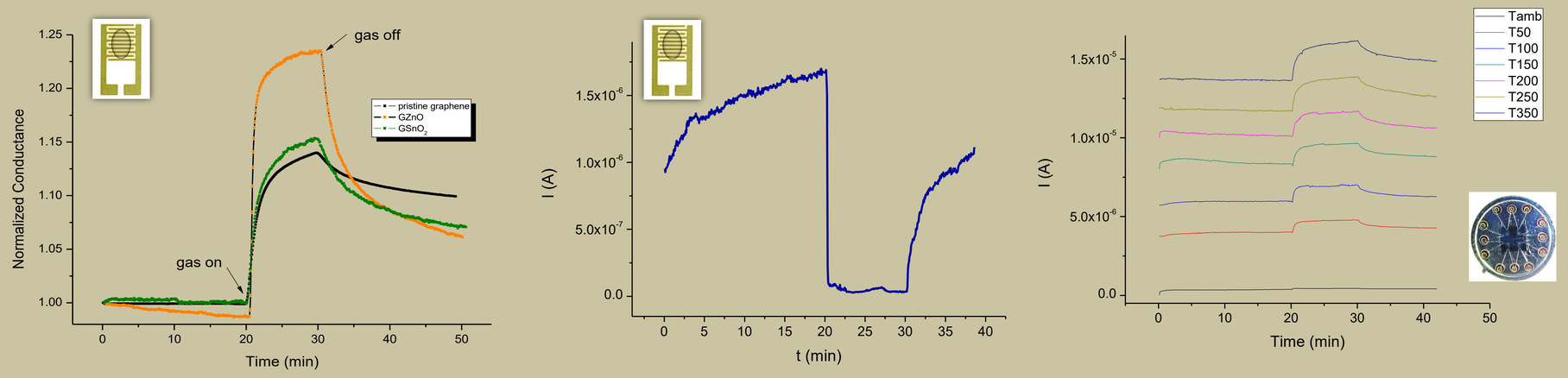
Sensing layers characterization



Device characterizations



NO_2 sensing response



*Dynamic response of **pristine graphene**, GZnO and GSnO2 sensors to 1 ppm NO2 at room temperature*

Dynamic response of GTiO2 sensor to 1 ppm NO2 at room temperature

Dynamic response of the GSnO2 device to 1 ppm NO2 in the whole temperature range

Improvements of the responses were obtained for ZnO and TiO2 decorated materials at room temperature. In particular, device based on TiO2 decorated graphene shows a remarkable sensitivity gain towards NO2 gas.

For all the MOx decorated graphene, a sensing response increase with increasing the temperature is detected.

Finally, an overall enhancement of the sensor performance in terms of sensitivity and/or response time is demonstrated.

Conclusions

Results confirm that it is possible to tune graphene based sensor performance in terms of sensitivity and/or response time towards NO_2 gas and, in turn, that the functionalization with metal oxide nanoparticles can be an effective tool to modify the graphene sensing properties.

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