Love-wave sensors based in graphene oxide for the detection of chemical warfare agent simulants

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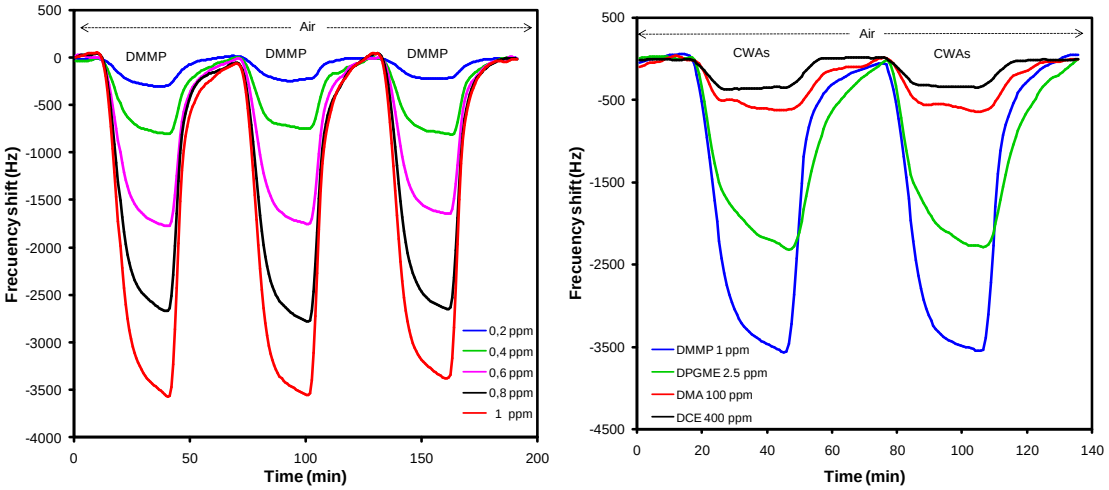
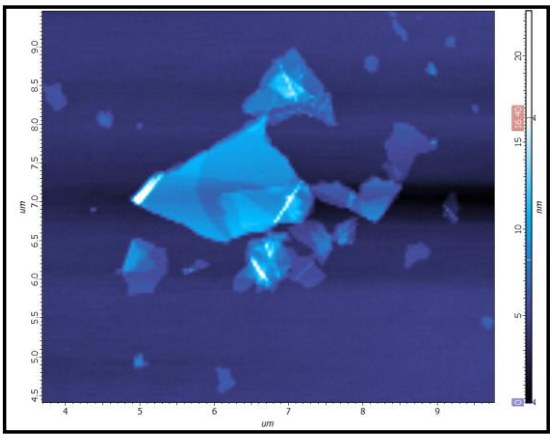
Abstracts:
Nowadays there is intense interest in the application of graphene and related materials (primarily, graphite oxide and its colloidal suspensions and materials made from them), from the sensitive materials perspective in gas sensors.
Surface acoustic wave (SAW) sensors have been applied in the fields of chemical and biological sensing. Given that the acoustic energy is confined near a thin surface region of the substrate to achieve this,Love-mode acoustic wave devices have been developed. These devices are based in the excitation of shear horizontal surface acoustic waves (SH-SAW) in a piezoelectric substrate, guided by a layer deposited over it, named waveguide layer. The Love-wave SAW sensor is composed of a piezoelectric substrate, a guiding layer and a sensitive layer for gas/liquid detection. This sensors are highly sensitive to surface perturbation of the propagating medium, allowing the surface wave device to operate as mass or viscosity sensor (in liquid environments). A key issue in the design of SAW sensors is the choice of sensitive layer.
Graphene oxide (GO) is a very attractive nanomaterial for sensor applications as it combines 2D structural features of graphene and the presence of oxygen-containing functional groups (mainly, epoxide, hydroxyl and carbonyl groups) (1,2) which can potentially interact with a great variety of analytes. Besides, GO offers promise for its use as substrate to be interfaced with biomolecules and cells for biological detection. Recent studies have focused on the applications of the GO in resistive sensors for the detection of pollutant gases (such as CO_2, NH_3, H_2, NO), chemical warfare agent (CWAs) and explosives (3,4). However, to the best of our knowledge, GO has hardly been used in SAW or Love-wave sensors (5).
We have developed a Love-wave SAW sensor with three-layer structure consists in ST-cut quartz as substrate, SiO_2 as guiding layer and GO as sensitive layer. In this work, we present the first results obtained with GO Love-SAW sensor for the detection of CWA simulants. The sensor detected very low concentrations of dimethyl-methylphosphonate (DMMP) and dipropylene glycol monomethyl ether (DPGME), simulants of sarin nerve gas and nitrogen mustard, respectively.



Dynamic response at room temperatures in synthetic air atmosphere of the Love-wave sensor to different concentrations of DMMP (left) and of different CWA simulants tested (right).



AFM topography image of the GO material used.

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