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LAMOS - Layered Amorphous Metal Oxide Gas Sensors: New Interfaces for Gas Sensing Applications

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Abstract : Despite their potential in gas sensing applications, the major drawback of 2D exfoliated metal dichalcogenides (MDs) is that they suffer from spontaneous oxidation in air, showing poor chemical stability under dry/wet conditions even at room temperature, limiting their practical exploitation. The aim of this work is to validate a synthesis strategy allowing microstructural and electrical stabilization of the oxides that inevitably form on the surface of 2D dichalcogenides. Taking advantage of spontaneous oxidation of MDs in air, we report on liquid phase exfoliated 2D-SnSe2 flakes annealed in static air at a temperature below the crystallization temperature of the native a-SnO2 oxide. This process yields a new class of 2D Layered Amorphous Metal Oxides Sensors (LAMOS), specifically few-layered amorphous a-SnO2, showing excellent gas sensing properties. Sensing tests were carried out at low operating temperature (i.e. 100°C) by exposing a-SnO2 to both oxidizing and reducing gases (i.e. NO2, H2S and H2) and different relative humidities ranging from 40% to 80% RH. The formation of stable nanosheets of amorphous a-SnO2 guarantees excellent reproducibility and stability of the response over one year. These results pave the way to new interesting research perspectives out considering the opportunity to synthesize homogeneous amorphous textures with no grain boundaries, no grains, no crystalline planes with different orientations, etc., following gas sensing mechanisms that likely differ from that of traditional crystalline metal oxide sensors. Moreover, the controlled annealing process could likely be extended to a large variety of Transition Metal Dichalcogenides (TMDs) and Metal Chalcogenides (MCs), where sulfur, selenium, or tellurium atoms can be easily displaced by O2 atoms ($\Delta G < 0$), enabling the synthesis of a new family of amorphous interfaces.

Keywords : layered 2D materials, exfoliation, lamos, amorphous metal oxide sensors
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