Functionalized graphene oxide: A versatile platform for sensing

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During the last decade, two-dimensional materials (2DMs) have attracted great attention due to their unique chemical and physical properties, which make them appealing platforms for diverse applications in opto-electronic devices, energy generation, storage, and sensing. Among their various extraordinary properties, 2DMs possess high surface area-to-volume ratios and ultra-high surface sensitivity to the environment, which are key characteristics for applications in sensing. Furthermore, 2DMs' superior electrical and optical properties, combined with their excellent mechanical characteristics such as robustness and flexibility, make these materials ideal components for the fabrication of a new generation of high-performance physical and chemical sensors.
Graphene oxide (GO) combines the unique characteristics of graphene and related 2DMs such as the high mechanical strength and large surface area with an easy, low-cost, and scalable production. The oxygen functionalities, which consist mostly of hydroxyl and epoxy groups exposed on the basal plane and carboxy and carbonyl functionalities located at the sheet edges, are extremely reactive, thus allowing further modification of GO. Importantly, the electrical conductivity can be to a great extent restored and tuned during the reduction step of the functionalized graphene oxide (fGO), making it an extremely versatile material for sensing with electrical readouts.
Here, we will discuss piezoresistive pressure sensor based on a millefeuille-like architecture of reduced graphene oxide (rGO) intercalated by covalently tethered molecular pillars holding on-demand mechanical properties are fabricated. By applying a tiny pressure to the multilayer structure, the electron tunnelling ruling the charge transport between successive rGO sheets yields a colossal decrease in the material's electrical resistance.
We will also discuss novel generation of humidity sensors based on a simple chemical modification of rGO with hydrophilic moieties, i.e., triethylene glycol chains. Such a hybrid material exhibits an outstandingly improved sensing performance compared to pristine rGO such as high sensitivity (31% increase in electrical resistance when humidity is shifted from 2 to 97%), an ultrafast response (25 ms) and recovery in the subsecond timescale, low hysteresis (1.1%), excellent repeatability and stability, as well as high selectivity toward moisture.

References

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