FLAG-ERA

Joint Transnational Call 2019

PeroGaS: Solution-Processed Perovskite/Graphene Nanocomposites for Self-Powered Gas Sensors

Main area: Sensors from GRMs and their heterostructures
Keywords: metal halide perovskites; GRMs; graphene; rGO; nanocomposite; lead-free perovskites; gas sensor; air pollutant gases; sensing; self-powered; laser-fabricated interdigitated electrodes;
Duration: 36 months
Total project funding: € 657.725

Abstract

In the Forth Industrial Revolution, characterized by a surge in the demand for automation and smart devices which have to ensure/enable multitasking, real-time data acquisition will play a prominent role. In this context, sensors can identify and track external stimuli and translate them into electrical signals. The PeroGaS project aims to design and develop novel sensors for gaseous air pollutants (CO2, CO, O3, NOx and SOx), which can be integrated into the Internet of Things. An ideal gas sensor should be ultra-sensitive, self-powered (i.e. requiring no external stimuli to operate), selective, environmentally friendly, cost-effective and exhibit a fast response time. PeroGaS proposes the development of an innovative sensing composite material consisting of all-inorganic metal halide perovskite crystals that are conjugated to reduced graphene oxide (rGO). This sensing material will be deposited directly onto rGO laser-fabricated interdigitated electrodes. Since best performing perovskite materials are currently based on Pb, our first goal will be to develop lead-free perovskites to mitigate the possible toxicity issues related to the use of Pb. At the same time, the electrodes will be environmentally sustainable, as they will be based on rGO rather than indium tin oxide (ITO) or noble metals. The suggested sensing elements are solution processable, therefore compatible with printed electronics concepts, including the direct growth and/or an easy deposition of the materials onto substrates which can be also flexible (e.g. cellulose). To-date, sensing elements based on graphene related materials (GRMs) are usually functionalized with metal oxides and operate only if they are triggered by an external stimulus, like UV or heating sources. Our recent work demonstrates the great potential of perovskites as sensing elements for ozone detection without using an external trigger. In this context, an important challenge of PeroGaS will be to develop and exploit lead-free graphene-perovskites conjugates for gas detection. A second challenge will be to address gas selectivity, a major breakthrough in sensor technology, which has only been realized, to date, using arrays of different materials. For this purpose, by using Stimulated Raman Scattering we will identify the specific vibrational features of the targeted gases (air pollutants) through light modulation. This technique can quantify the contribution of the adsorbed gases to the produced electrical signal, thus "calibrating" the sensor. At the end of this project, we will fabricate a prototype "nano" gas sensor, adaptable to smart/portable devices that can be used to monitor the quality of breathing air in homes, cities. Such sensor can also be implemented in other sectors such as in transportation, industry and agricultural production. This sensor will improve the standard of living, fulfilling the Graphene Flagship Core Project's aims (Division 2, WP6).

Consortium

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