In-situ functionalized E-Graphenes and the potential for energy storage and hydrogen production

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Abstract

The process of electrochemical exfoliation and functionalization of graphene, developed at TU Dresden and patented by Sixonia Tech GmbH[1] creates the ability to functionalize few-layer graphenes deliberately and precisely, directly during their production. This versatility allows us to modify graphene solutions to suit selected substrates, intermediates or end compounds. Building the knowhow to tailor the graphene-solution-substrate systems enables us to achieve desired performance goals and meet particular application process requirements. By providing good scalability and yield, low production costs and the good processability, our mission is to unleash the currently limited potential of graphene in various fields including the energy and environmental markets.

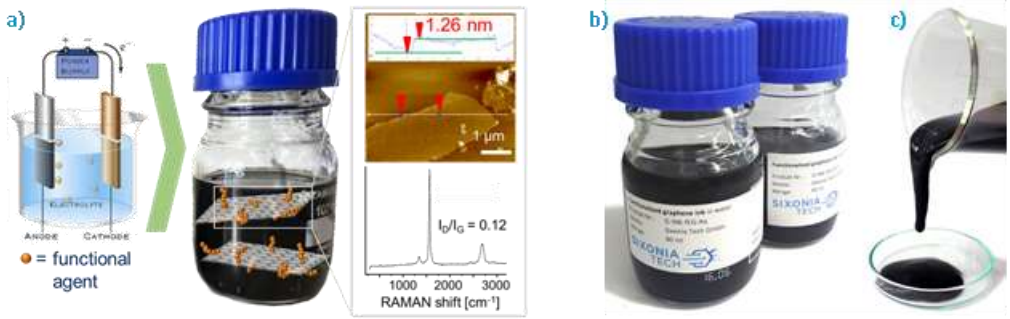

Figure 1: Surfactant-free dispersion of functionalized high-quality few-layer graphene (a), conductive inks (b) and high viscosity formulations (c) based on our advanced E-Graphenes.

The scalable and eco-friendly process technology opens up new possibilities and prospects for the applications of graphene, in the field of inks, pastes and additive formulations for energy storage and energy conversion applications. As a by-product of our electrochemical process hydrogen is produced which, if harvested, bears the potential to further improve the economics of our production process.

As an example, our E-Graphenes can be functionalized to be dispersible in water, NMP and other solvents without the need for surfactants (Fig. 1), while still maintaining an intrinsic conductivity that is at least one order of magnitude higher than that of commonly used reduced graphene oxide (rGO) materials. This makes our graphene the ideal material to replace classic carbon blacks as a conductive additive in battery electrode formulations.
Compared to other "graphene" products, E-Graphenes show a superior combination of tailorable properties within a single material, such as large flake-size in the µm-range, low thickness in the range of typically 1-5 layers and good processability. Unlike in GO, the defined functional groups can povide an improved processability while still maintaining high electrical conductivity and reasonable sheet size.
Furthermore, our proprietary functionalization process also allows us to introduce electrochemically active moieties (both organic and inorganic) to introduce additional (pseudo-)capacity for use in supercapacitors as both anode and cathode active materials.

References

[1] Sixonia Tech GmbH; Int. Pat. Appl. PCT/EP2018/085825, 2018