Water-based and biocompatible inks made of 2D materials for all-printed heterostructures

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Abstract:
Solution processing of 2D materials allows simple and low-cost techniques such as inkjet printing [1, 2] to be used for fabrication of heterostructures of arbitrary complexity. However, the success of this technology is determined by the nature and quality of the inks used. Furthermore, these formulations must be suitable for all-inkjet printed heterosturcture fabrication, which is very challenging because of the remixing of different 2D crystals at the interface, resulting in poor performance and lack of reproducibility.
In this work we show a general formulation engineering approach to achieve highly concentrated and inkjet printable water-based 2D crystal formulations, which also provide optimal film formation for multi-stack fabrication [3]. Examples of all-inkjet printed heterostructure, such as arrays of photodetectors, logic memory devices, strain sensors [4] and capacitors [5] will be discussed.
This approach relies on Liquid-phase exfoliation, which has limited scalability and it is time consuming. Electrochemical exfoliation [6] is a simple and scalable technique, which involves the use of an electrolyte and an electrical current to encourage structural delamination of a graphite electrode. In particular, anodic ECE allows achieving exfoliation in few minutes [6]. In the last part of this talk, we show a water-based inkjet printable ink made from electrochemically exfoliated graphene containing single and bilayers graphene [Parvez et al, submitted]. In particular, thermal annealing of the printed graphene allows achieving electrical conductivity of 3.9 × 10^4 S/m, which is one of the highest conductivity.

References

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Figures

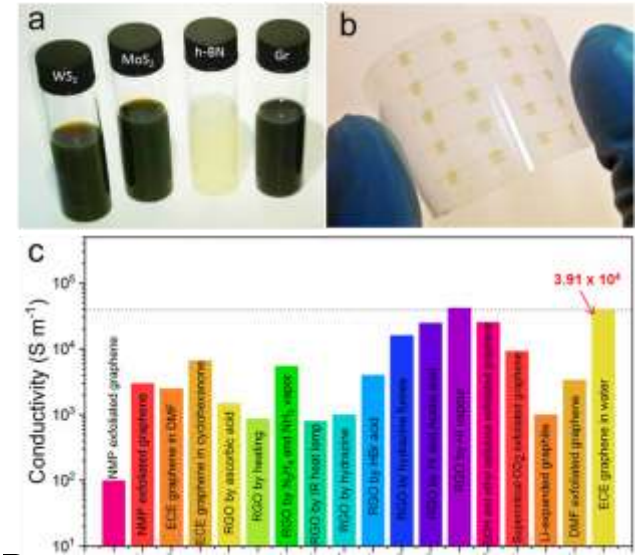

Figure 1: (a) Optical image of water-based 2D-crystal inks, (b) Optical picture of an array of all-printed Gr/WS_2/Gr heterostructure on PET (c) Comparison of the electrical conductivity of our electrochemically exfoliated graphene ink with literature results based on different types of inkjet printable graphene formulations.