Water-based, defect-free and biocompatible 2D material inks: from printed devices to biomedical applications

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Solution processing of 2D materials [1] allows simple and low-cost techniques, such as ink-jet printing, to be used for fabrication of heterostructure-based devices of arbitrary complexity. However, the success of this technology is determined by the nature and quality of the inks used.
In my group we have developed highly concentrated, defect-free, printable and water-based 2D crystal formulations, designed to provide optimal film formation for multi-stack fabrication [2]. I will give examples of all-inkjet printed heterostructures, such as large area arrays of photosensors on plastic [2], programmable logic memory devices [2], capacitors [3] and transistors on paper [3,4]. Furthermore, inkjet printing can be easily combined with materials produced by chemical vapor deposition, allowing simple and quick fabrication of complex circuits on paper, such as high-gain inverters, logic gates, and current mirrors [5].
If time allows, I will show that our formulation approach also allows to easily tune the charge of graphene, which is a key parameter in biomedical applications. Amphoteric, cationic and anionic dispersions have been obtained without any post-processing after exfoliation [6-8]. Cytotoxicity tests confirm biocompatibility of the graphene inks, with cationic graphene dispersions having exceptional intracellular uptake profile as well as stability in the biological medium, even with protein serum, making this type of graphene very attractive to use in nanomedicine [7].

References

[1] Coleman et al, Science 331, 568 (2011)
[2] McManus et al, Nature Nano, 12, 343 (2017)
[3] Worsley et al, ACS Nano, 2018, DOI: 10.1021/acsnano.8b06464
[4] Lu et al, ACS Nano, ACS Nano, 13, 11263 (2019)
[5] Conti et al, Arxiv. 1911.06233
[5] Shin et al, Mol. Syst. Des. Eng., 2019, DOI:10.1039/C9ME00024K
[6] Shin et al, Faraday Discussion, accepted
[7] Shin et al, Nanoscale, 2020, DOI: 10.1039/D0NR02689A