Water-based, biocompatible 2-D inks for printed electronics

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Credit: University of Manchester

Researchers at The University of Manchester have developed a method of producing water-based and inkjet printable 2-D material inks, which could bring 2-D crystal heterostructures from the lab into real-world products.

Examples include efficient light detectors, and devices that are able to store information encoded in binary form which have been demonstrated, in collaboration with the University of Pisa.

Graphene is the world's first 2-D material: 200 times stronger than steel, lightweight, flexible and more conductive of copper. Since graphene's isolation in 2004 the family of 2-D materials has expanded.

Using graphene and other 2-D materials, scientists can layer these materials, similar to stacking bricks of Lego in a precisely chosen sequence, known as "heterostructure", to create devices tailored to a specific purpose.

As reported in *Nature Nanotechnology* a team led by Professor Cinzia Casiraghi have developed a method of producing water-based and inkjet printable 2-D material inks, which can be used for the fabrication of a wide range of heterostructures by fully exploiting the design flexibility offered by a simple technique such as inkjet printing.

Current ink formulations, which would allow heterostructures to be made by simple and low-cost methods, are far from ideal- either containing toxic solvents or requiring time-consuming and expensive processes. In addition, none of these is optimised for heterostructure fabrication.

Prof Cinzia Casiraghi said: "Due to the simplicity, flexibility and low cost of device fabrication, we envisage this technology to find potential in smart packaging applications, for example for pharmaceuticals and

consumer goods. We are also very excited about the possibility of implementing logic circuits made of 2-D materials – indeed, we are further developing these type of devices with our colleagues in Pisa".

Daryl McManus, PhD student said: "These inks provide a perfect platform to fully exploit the range of properties of 2-D materials by allowing for the first time a precise and scalable method for fabrication of devices of arbitrary complexity utilising 2-D materials".

Most notably these inks are also biocompatible, which extends their possible use to biomedical applications.

Prof Kostas Kostarelos, Professor of Nanomedicine said: "The engineering of water-soluble 2-D inks that are compatible with the biological milieu and interact with organisms without harm can provide a platform of huge potential for a wide range of applications. We are certainly looking at this as the beginning for such inks in the biomedical arena."

More information: Daryl McManus et al. Water-based and biocompatible 2D crystal inks for all-inkjet-printed heterostructures, *Nature Nanotechnology* (2017). DOI: 10.1038/nnano.2016.281

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