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Graphene solution

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Graphene—carbon atoms in a single honeycomb sheet—is proving to be a remarkable material because of its excellent electron transport properties and potential applications. Reproducible ways of synthesizing this material are still under development, however, and a simple means of depositing films is still elusive.

Ho and colleagues from the National University of Singapore¹ have developed a procedure to create high-quality and contaminant-free graphene oxide nanosheets using a solution process. The nanosheets can be inkjet-printed and spin-cast to make devices.

The researchers started by partially oxidising graphite, which yielded graphene oxide. Then, they functionalized this sub-stoichiometric graphene oxide with alkyl chains to produce a black dispersion that was stable for at least six months. The solutions were purified by centrifugation, and simply spin-coated or printed onto substrates resulting in films of thicknesses between one single layer (Fig.1) and tens of micrometers.

The films were then annealed, producing graphene—oxygen was lost and pi-bonds created between

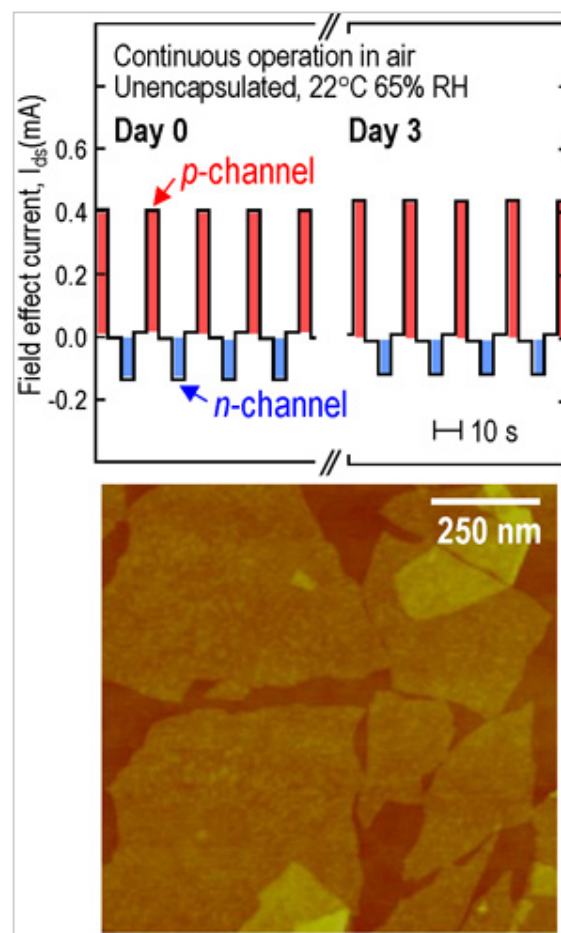



Fig.1. Atomic force microscopy image of a monolayer functionalized graphene oxide film



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the carbon atoms. Before annealing, the conductivity of the films was very low, but between 180°C and 300°C, the formation of a percolation pathway of pi-bonds across the films led to a sharp rise of the conductivity. At 300°C, the conductivity increased by eight orders of magnitude from its initial value. Cooling the annealed films resulted in these films returning to their pre-annealed, low-conductivity state.

Despite the fact that the films were disordered and contained defects, they exhibited high-quality, trap-free band transport of both electrons and holes. Furthermore, even after days of operation in air, graphene transistors showed no deterioration in their charge transport properties.

“Our work shows that with proper control of the chemistry of the graphene, the electronic transport in such 2D materials is tolerant of disorder,” says team leader Lay-Lay Chua.

This simple approach should also have major consequences for graphene applications. “Using these solution-processed materials, we can demonstrate very robust and well-behaved transistor behaviour. This is very surprising for graphene materials obtained through the oxide route,” says Chua.

Reference

1. Wang, S. *et al.* Band-like Transport in Surface-Functionalized Highly Solution-Processable Graphene Nanosheets. *Adv. Mater.* **20** 3440–3446 (2008). | [article](#) |
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made by spin-casting , showing large unwrinkled sheets, and no amorphous carbon contamination.

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