Graphene products for micro and macro-electronics

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Abstract

Graphene-based and two-dimensional materials are approaching the industrial production stage at a sustained pace [1]. These materials can be obtained by bottom-up and top-down approaches like, for example, chemical vapor deposition (CVD) and liquid phase exfoliation (LFE), respectively. While CVD is particularly suitable for growing high-grade single-layer graphene (on a metal catalyst) for microelectronics, LFE methods allow for the direct deposition of multi-layered films low cost that are compatible with a wide range of large-area substrates for macro-electronics [2]. CVD graphene's atomically-thin nature, high carrier mobility, and chemical stability allow fabricating relatively simple, label-free, highly sensitive biosensors based on different types of devices. Here, we show a microelectronics biosensing platform based on liquid-gate graphene field-effect transistors achieving detection of DNA hybridization down to attomolar concentration while being able to discriminate a single nucleotide polymorphism (SNP) [3].
To date, graphene LFE dispersions present some limitations, particularly the use of efficient yet hazardous solvents with limited substrate compatibility, high boiling point, and toxicity, which are all undesirable features for industrial production. We propose a novel approach, with high yield and control on the material properties that uses a green carbon solvent – Cyrene, to replace toxic and hazardous solvents such as NMP and DMP in the exfoliation process. Using a combination of shear mixing and ultra-sonication with tuned conditions (such as time, frequency, and power), we obtained stable graphene dispersions with concentrations above 4 mg/mL (with lateral size of the graphene flakes between 30 and 500 nm). The dispersions were then deposited by spray coating on flexible PET substrates to successfully fabricate, as a proof of concept, a macro-electronics 20x20 channel multi-touch screen prototype.
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REFERENCES

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FIGURES

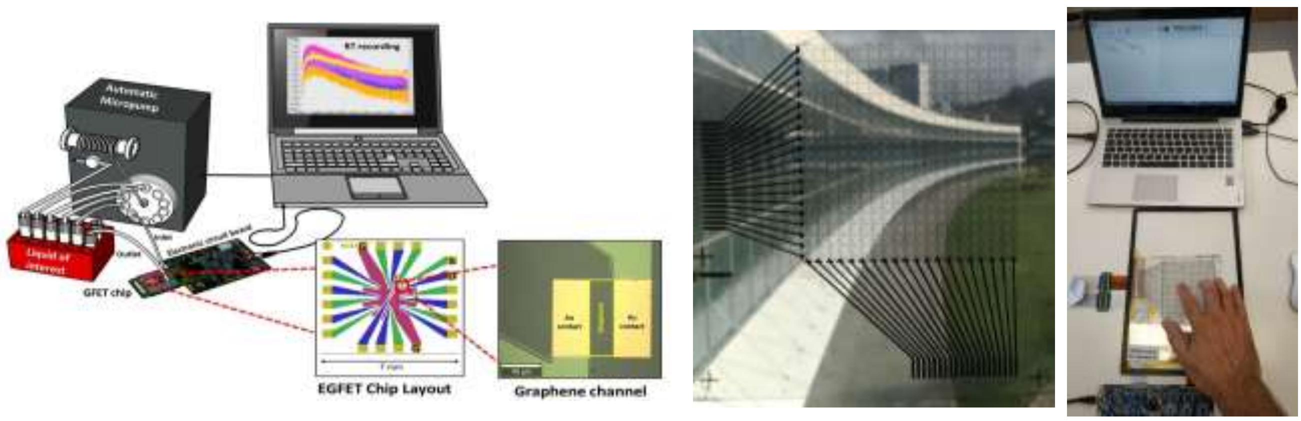

Figure 1: (left) The integrated portable system with automatic micropump and electronic reader of the graphene transistors chip; (right) graphene 20x20 channel multi-touch screen fabricated on PET.