All-2D Material Inkjet-Printed Capacitors: Toward Fully Printed Integrated Circuits

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A well-defined insulating layer is crucial within integrated circuits for the fabrication of both passive and active components, such as capacitors and transistors. The best-known 2D dielectric material is hexagonal boron nitride (hBN). Synthesis includes both chemical vapour deposition (CVD) [1], [2] and solution-based techniques [3-5]. Whilst CVD offers high material quality, the procedures are time-consuming and costs are high. Solution-processing techniques are inexpensive, but suffer from poor design flexibility and large amounts of waste. In comparison, inkjet printing provides a cost-effective and non-contact approach to 2D-material capacitor fabrication, allowing for maximum design flexibility, producing no material wastage and offering compatibility with almost any substrate of interest. In this work, we use water-based and biocompatible graphene and hBN inks to fabricate all-2D material and fully inkjet-printed capacitors [6]. We demonstrate a high areal capacitance of 2.0 ± 0.3 nF cm^{-2} for a dielectric thickness of ~3 µm, giving rise to a derived dielectric constant of 6.1 ± 1.7, averaged across more than 100 devices. The inkjet printed hBN dielectric layer exhibits negligible leakage currents, with a breakdown field of 1.9 ± 0.3 MV cm^{-1}. The hBN dielectric has additionally been exploited within two fully inkjet-printed demonstrators: an RC low-pass filter and a graphene-based field effect transistor [6], showing excellent performance.

References

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Figures

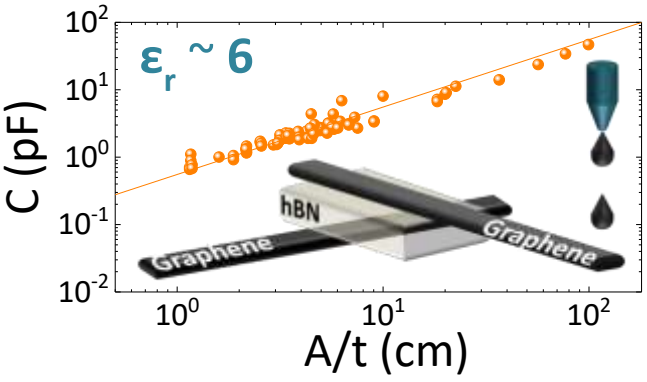

Figure 1: Device capacitance plotted as a function of the hBN dielectric area to thickness (A/t) ratio, showing the linear fitting from which the dielectric constant ($\varepsilon_r \sim 6$) is derived.