Inkjet-printed two-dimensional material biosensors on flexible substrates

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The availability of rapid, sensitive, low-cost diagnostic tests available at the point-of-care (PoC) is an important technical challenge in health.[1] In the slew of proposed sensor technologies, two-dimensional materials (2DMs) stand out as promising candidates due to their unique mix of characteristics.[2] Graphene for example, is a biocompatible, stable, semi-metal with high mobility which is well suited for sensing of biologically relevant analytes.[3] Moreover, 2DMs can be dispersed as inks – combining conducting, insulating and semiconducting inks together offers a route for economical, flexible printed electronics devices on a wearable platform. However, challenges persist in producing stable, high-concentration inks for scalable production of such printed electronic devices made using 2DMs.[4]

In this work, we demonstrate inkjet-printed biosensors on rigid and flexible form factors for wearable applications. Devices are fabricated using graphene ink as the active layer, h-BN inks as the dielectric material and MXene and silver inks as the electrodes. A systematic analysis of alcohol-polyvinylpyrrolidone (PVP) based 2DM inks was carried out to enhance ink stability and achieve concentrations ranging from 0.1 mg mL^{-1} to > 10 mg mL^{-1}. Raman spectroscopy indicated that the inks comprised of electronically decoupled layers of graphene. The lateral flake size was characterized by AFM, SEM and TEM, with a likely modal average of 0.4 – 0.5 µm within a range of flakes extending between 0.2 µm and 5 µm and flake thicknesses of up to 30 nm. The synthesized inks were then inkjet-printed and used as biosensors in proof-of-principle structures.

References

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Figures

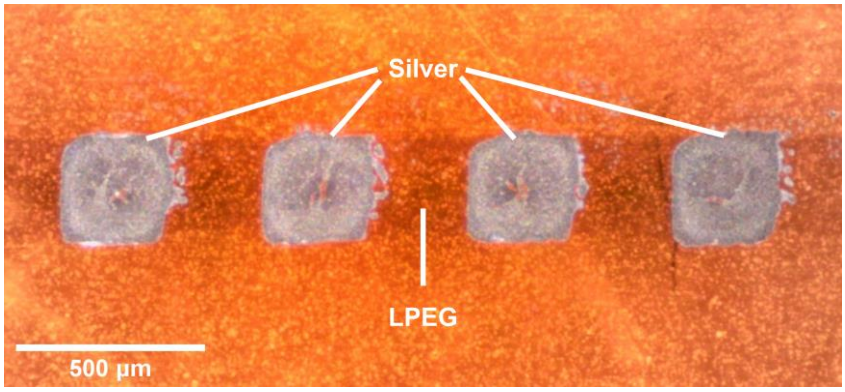

Figure 1: Inkjet-printing of graphene active area with silver electrodes on top, printed on polyimide.