**Electrochemical Engineering of 2D Materials for Smart Devices**

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Although graphene oxide (GO) has shown enduring popularity in the research community, its synthesis remains cost prohibitive for many of its demonstrated applications. While significant progress has been made on developing an electrochemical route to GO, existing methods have key limitations regarding their cost and scalability. To overcome these challenges, we employ a combination of highly robust boron-doped diamond (BDD) with a wide electrochemical potential window and commercially available fused deposition modelling (FDM) 3D printing to fabricate a scalable packed-bed electrochemical reactor (PBER) for GO production. The scalability of the reactor along the vertical and lateral dimensions was systematically demonstrated to facilitate its eventual industrial application. Our current reactor is cost-effective and capable of producing electrochemically derived graphene oxide (EGO) on a multiple-gram scale. The as-produced EGO is dispersible in water and other polar organic solvents (e.g. ethanol and DMF) and can be exfoliated down to predominantly single-layer graphene oxide. The simplicity, cost-effectiveness and unique EGO properties make our current method a viable contender for large-scale synthesis of graphene oxide. Subsequently, we have demonstrated a new efficient technique for 3D printing of conductive PDMS/graphene ink by using an emulsion method to form a uniform dispersion of PDMS nanobeads, EGO and PDMS precursor binder. The formulated nanocomposite ink exhibits high storage moduli and yield stress that can be employed for Direct Ink Writing (DIW) 3D printing. Due to the unique hybrid structure of PDMS and EGO sheet, the 3D printed EGO/PDMS nanocomposite possesses high, linear and reproducible sensitivity that is suitable for application as skin-attachable wearable health monitoring device. Introduction.

**References**

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