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Electrochemical Engineering of Graphene Oxide for Wearable Smart Devices

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Data: 13th March 2019, Wednesday

Time: 3:30-4:30 pm

Venue: ST 602 (4D Theatre), POLYU

Abstract:

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.

Reference:

[1] Lowe, S. E., Shi, G., Zhang, Y., Qin, J., Wang, S., Uijtendaal, A., Sun, J., Jiang, L., Jiang, S., Qi, D., Al-Mamun, M., Liu, P., Zhong, Y. L., Zhao, H. Scalable Production of Graphene Oxide Using a 3D-Printed Packed-Bed Electrochemical Reactor with a Boron-Doped Diamond Electrode. ACS Appl. Nano Mater. (2019) DOI: 10.1021/acsanm.8b02126

[2] Tian, Z., Yu, P., Lowe, S. E., Pandolfo, A. G., Gengenbach, T. R., Nairn, K. M., Song, J., Wang, X., Zhong, Y. L., Li, D. Facile Electrochemical Approach for the Production of Graphite Oxide with Tunable Chemistry. Carbon 112, 185-191 (2017).

[3] Yu, P., Tian, Z., Lowe, S. E., Song, J., Ma, Z., Wang, X., Han, Z., Bao, Q., Simon, G. P., Li, D., Zhong, Y. L., Mechanically-Assisted Electrochemical Production of Graphene Oxide. Chem. Mater. 28, 8429-8438 (2016).

[4] Lowe, S. E. & Zhong, Y. L., Chapter 13: Challenges of Industrial-Scale Graphene Oxide Production, Graphene Oxide: Fundamentals and Applications (ed. A. Dimiev & S. Eigler), John Wiley & Sons, Ltd., United Kingdom, 2016, ISBN: 978-1-119-06940-9.

[5] Yu, P., Lowe, S. E., Simon, G. P. & Zhong, Y. L, Electrochemical Exfoliation of Graphite and Production of Functional Graphene. Curr. Opin. Colloid Interface Sci. 20, 329 (2015).

Biography:

Dr. Yulin Zhong completed his PhD in Chemistry at the National University of Singapore (NUS) and did his post-doctoral training at Princeton University (2009) and Massachusetts Institute of Technology (2011). After spending three years in the USA, he worked as a Research Scientist at the Institute of Bioengineering and Nanotechnology, A*STAR Singapore, (2012) and thereafter, as an ARC DECRA Fellow at Monash University (2013). He is currently a Senior Lecturer at the School of Environment and Science, Griffith University (Gold Coast campus) and a full research member of the Centre for Clean Environment and Energy (CCEE).

ALL ARE WELCOME!