Inkjet Printing of Graphene Inks for Wearable Electronic Applications

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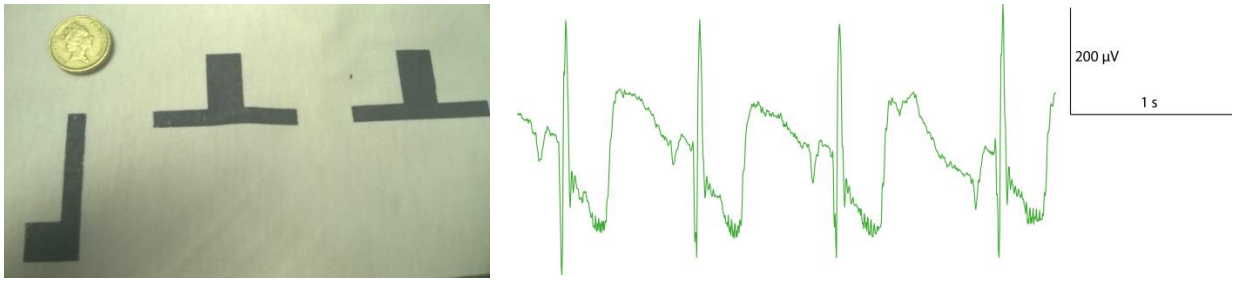
Abstract

Inkjet printing of graphene-based conductive inks is an encouraging research approach in the field of printed electronics as both the benefits of inkjet printing and extra-ordinary electronic, optical and mechanical properties of graphene can be exploited [1]. Inkjet printing is one of the most promising techniques for the fabrication of wearable electronics due to number of advantages over conventional manufacturing techniques such as digital and additive patterning, reduction in material waste, deposition of controlled amount of materials and compatibility with various substrates [2]. In addition, graphene is a single atom thick two-dimensional closely packed honeycomb lattice of sp^2 carbon allotropes, which has been focus of mass investigations in recent years because of its unique physical and chemical properties [3].

Currently silver nanoparticles (NPs) as inkjet printing inks are the most reported and utilised conductive inks because of their excellent electrical conductivity and strong antioxidant characteristics [4]. However higher concentration of NPs and higher sintering temperatures are required in order to obtain continuous metallic phase, with numerous percolation paths between metal particles within the printed pattern [5], which increased processing cost and limited the choice of substrates to be printed because of their heat sensitivity. Inkjet printing of reduced graphene oxide (rGO) are reported in several studies as a popular choice to fabricate wearable devices due its advantages such as readily dispersible in water and high volume production at lower cost [6]. However large number of unreduced oxygen-containing functional groups and inter-sheet junctions between the graphene domains limits the conductivity achieved with rGO [7]. In order to overcome the limitations associated with rGO inkjet inks, pristine graphene inks were developed and printed.

Herein we report exfoliation of pristine graphene dispersions produced in gram scale quantities based on literature review [8, 9]. Liquid phase exfoliation method was used by shear mixing in the presence of a polymer stabilizer, ethyl cellulose which enhances the ink stability as well as printing

performance [2, 10]. To formulate ink for inkjet printing graphene/ethyl cellulose powder was directly dispersed in a mixture of solvents by bath sonication. Then the formulated inks were successfully inkjet printed onto textile substrate in order to fabricate an Electro-Oculogram (EOG) device for healthcare applications, Figure 1.



(a) (b)

Figure 1 Graphene printed electrodes on textile substrates for bio-sensing without requiring a fixed connection to the body

Keywords

Graphene Inks, Inkjet Printing, Wearable Electronics and EOG

Biography

Shaila Afroj is a second year PhD student at the University of Manchester. After working almost five years in multinational companies such as C&A and Intertek, and two years MA By Research from University of Huddersfield, she joined centre for digital fabrication research group at The University of Manchester in 2015. She is currently investigating the formulations of 2D materials inks for printed electronic applications using various printing techniques.

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