Printing and Patterning of Conductive Graphenic Nanomaterial-Polymer Composites

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Advances in both manufacturing techniques and materials are leading to the development of a new class of flexible, inexpensive and light-weight electronic devices, with applications in areas which include antennas for supply-chain monitoring, wearable electronics, and distributed sensors for internet-of-things. Graphenic nanomaterials are attractive in this field based on two main properties: (1) they are electrically conductive, and (2) they can be processed and patterned outside of a traditional cleanroom using techniques such as casting and printing. While layers of materials such as graphene and reduced graphene oxide (rGO) can be printed directly to form conductive traces, these layers tend to be brittle and lack stability in varying environments (e.g. undergoing a change in conductivity as the humidity varies).

The focus of our work is to engineer graphenic-nanomaterial polymer composites that can be patterned from solution using 2D or 3D printing. When conducting particle fillers (such as graphene nanomaterials) are introduced into a matrix of insulating polymer, a conductive composite material may be achieved, even at a relatively low concentration of conductive filler. Judicious selection of a polymer matrix and conductive material can allow materials with tailored properties to be achieved. In the first part of the presentation I will describe our work engineering conductive composites from rGO and polyhydroxybutyrate, a hydrophobic, biocompatible polymer with high thermal stability and solvent-resistance [1]. In the second part of the presentation I will show how these materials can be patterned using solvent-casting and 3D printing to implement temperature responsive sensors which are highly selective to only the desired stimulus [2]. Finally, I will outline some challenges and opportunities for applying graphenic composite in 2D and 3D printing.

REFERENCES

[1] L Dan and AL Elias, Advanced Healthcare Materials 2020, 2000380.
[2] L Dan, M Pope, and AL Elias, Journal of Physical Chemistry C, 2018, 122 (30), 17490–17500.

FIGURES

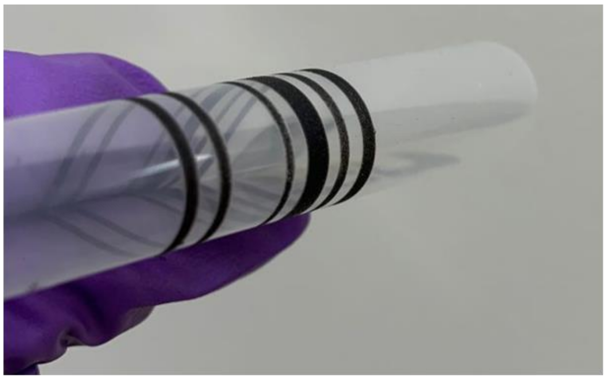

Figure 1: 2D rGO-PHB lines printed on a flexible substrate, shown here deformed (post-printing) into a cylindrical shape