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EMERGING 2D-NANOMATERIALS FOR ADDITIVE MANUFACTURING OF SPACE-GRADE HYBRID ELECTRONICS

Abstract

The development of printed electronics is growing rapidly, with much of the research focusing on the discovery of high-performance multifunctional inks compatible with existing additive manufacturing technologies. One of the more promising classes of nanomaterials for such applications is 2D materials. In particular, graphene has shown many promising properties and demonstrated breakthroughs in electronic-related applications, due to its high specific surface area, high carrier mobility,1–4 and a great sensor electrode material due to its flexibility and high electrochemical activity at defect sites.5–8 The bulk form of MoS2 is a semiconductor with an indirect bandgap (1.2 eV); whereas, monolayer MoS2 has a direct bandgap (1.8 eV). Transistors of MoS2 have exhibited high on/off ratios and very low power dissipation.9 The exemplary electrical and structural properties of 2D materials allow for the design of highly sensitive and selective systems while also limiting the cost, weight and energy consumption of electronic/optoelectronic devices. In this talk, we highlight our recent investigations into the use of 2D material inks for additive manufacturing of electronic and optoelectronic devices. We first report on the electrical transport and power dissipation properties of aerosol-jet printed graphene interconnect, emphasizing the role of device morphology and the substrate on device performance. Secondly, our preliminary data on inkjet printed graphene-based electrodes indicate graphene is a highly sensitive electrode to monitor electrolyte and pH balance in human sweat. Lastly, we also incorporated printed MoS2 into a photodetector, highlighting its potential as a semiconducting ink for lightweight optoelectronic devices that can withstand the high radiation exposures in space.10 We find the photocurrent response of the printed photodetector follows the frequency of the applied light signal as expected.11 Our results provide new insight into structure-property-processing correlations in printed 2D nanomaterial devices, with broader implications for the reliability of printed and flexible electronics for space applications.

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