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Scalable production of highly sensitive nanosensors based on graphene functionalized with a designed G protein-coupled receptor

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In order to support the Navy's goal of information dominance, new electronics technologies must be developed with increasingly higher performance and lower size, weight, power, and cost requirements. Graphene transistors have shown promise as next generation transistors, chem/bio sensors, optoelectronic devices, and thermal management interconnects; however, difficulties with scalability and reproducibility of devices have hindered the progress of these efforts. Across fields, there is a need for scalable, reproducible fabrication of arrays of graphene field effect transistors (GFETs) that maintain the intrinsically high graphene carrier mobility, which is significantly degraded due to contamination by conventional lithographic processing. This project investigates a GFET fabrication method which is scalable and reproducible in terms of the mobility and Dirac voltage with high yield. Large-area graphene grown by chemical vapor deposition is combined with an approach where graphene is patterned during the transfer process rather than by post-transfer photolithography. Resulting arrays of devices are of extremely high quality as evidenced by Raman spectroscopy and electronic transport measurements with device yield exceeding 99%. Devices are integrated with biomolecules to produce a novel, all-electronic biosensor for opioids that consists of an engineered μ-opioid receptor protein, with high binding affinity for opioids, chemically bonded to a graphene field-effect transistor to read out ligand binding. This advance enabled by nanotechnology may lead to a new generation of novel electronic devices with graphene transistors at their hearts.

Biography

Mitchell Lerner completed his PhD in Physics at the University of Pennsylvania, specifically studying carbon nanoelectronics and possible uses in sensor applications. He is the Director of the Functional Nano Devices Lab at SSC Pacific, an applied Navy warfighter lab. He has published more than 13 papers in reputed journals and filed over a dozen patents on applications of carbon nanotubes and graphene.

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