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Graphene biosensors for label-free detection of blood-based biomarkers for Alzheimer's disease

Statement of the Problem: Alzheimer's disease is the most common form of dementia leading to a massive irreversible neuronal loss and cognitive decline. It affects over 7 million people in Europe and 5.5 million in America and this figure is expected to double every 20 years as the population ages. Early detection of the AD is the key requirement for developing disease-modifying treatments as studies show that pathology exceeds symptom by years. The existing techniques for detection using CSF and Imaging biomarkers are highly expensive and invasive. Blood-based biomarkers, however, can provide a simple and effective way for the screening of AD patients. The talk covers the latest progress in the EU H2020 BBDiag research project, for the development of blood biomarker-based diagnostics for early-stage AD employing by multiplexed graphene biosensor arrays.

Methodology & Theoretical Orientation: Two novel graphene biosensors were developed for label-free detection of DNA and protein biomarkers, a graphene immunoFET for detection of protein markers and a rGO-graphene electrode for detection of DNA markers.

Findings: The rGO electrode shows enhanced redox current up to 40% higher in comparison with electrodes of bare graphene due to the combination of a high number of electroactive sites on rGO and high conductivity of pristine graphene. A linear range from 10-7M to 10-12M is demonstrated for the biosensor with a detection limit of 1.58 x 10-13M. The immunoFET showed a unique resistance change pattern with high reproducibility and an ultralow detection limit of 1pg mL^{-1} and high sensitivity of 0.30 Ω/ng/mL.

Conclusion & Significance: We have demonstrated that graphene biosensors can be employed for ultra-sensitive and label-free detection of DNA and proteomic disease biomarkers. The work may lead to the development of cost-effective and minimally invasive point of care diagnostic devices for routine screening of Alzheimer's disease with a panel of biomarkers.

Biography

Genhua Pan is a Professor and Head of Wolfson Nanomaterials & Devices Laboratory at the University of Plymouth, UK and Coordinator of EU H2020 Marie Curie network BBDiag. He has over 30 years of research and teaching experience in micro/nanoscale thin films and devices, information storage technology and electronic engineering. His current research interest encompasses graphene & 2D materials/devices, biosensors, renewable energy/solar cells, spintronics and magnetic data storage. Genhua graduated from Zhejiang University, China in 1981, worked in the Chinese Academy of Science until 1988 when he obtained a scholarship to visit Loughborough University for a year. He then joined Plymouth University in 1989, gained my PhD in materials and physics in 1993. Over the years, He has also worked with a number of institutions as a visiting researcher (Sony Research Centre, Yokohama, Japan, Akita Institute of Technology, Akita, Japan, and Seagate Technology, Northern Island). To date, he has published over 100 journal and conference papers, 3 book chapters and 6 patents.

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