University of Louisville
Department of Chemistry

Mohan Paudel

Literature Seminar

When: December 3, 2020
Time: 2:30 PM
Location: Microsoft TEAMS

Comparative Study of Fabrication of Laser Scribed Graphene (LSG) Using Different Substrates and Their Application in Biomolecules Sensing

Abstract

The analysis of biological fluids for health related biomarkers are necessary to monitor individual's well-being. Devices that inexpensive, easy to manufacture, and disposable are highly desired. In 2007, Whitesides and co-workers described a simple method for patterning paper to provide a quick and simple assay to analyze glucose and protein in the sample solution.[1] However, paper is not a good conductor of electricity and that poses a great challenge for its use as electrochemical sensor. Although there are methods like drop casting, inkjet printing, or screen-printing to cast solution of conductive particles on paper, these methods can leave residue in paper after evaporation.[2] Carbon based materials, especially graphene shows excellent potential in electrochemical sensing of biomolecules.[3] Mesoporous graphene electrodes with 3D interconnected carbon network show enhanced electrochemical performance compared to the classical planar 2D graphene electrodes.[4] Computer controlled laser scribing of different polymers or graphene oxide into graphene is one of the promising method to produce 3D mesoporous graphene.[5] Electroanalytical activity of laser scribed graphene (LSG) depends largely on the type of substrate used, its composition, structure and grammage (mass per unit area).[2]

Laser scribed graphene (LSG) prepared using three different types of substrates, paperboard, nitrogen doped lignin and polyimide were studied comparatively.[2,6,7] Active surface area of LSG electrodes from all three substrates was found to be two times or more compared to the geometric surface area. The charge transfer resistance of LSG electrode from paperboard was found to be low compared to glassy carbon electrode. It was patterned and silver ink painted in reference electrode so that it can be used independently as a sensor. LSG electrode prepared from nitrogen doped lignin had very low charge transfer resistance of 2.8Ω per square.[6] It was patterned and spray coated with MXene/Prussian Blue for increasing the sensitivity and functionalized with catalytic enzymes to detect glucose, lactate and alcohol from sweat.[6] LSG electrode prepared from polyimide substrate contained vertically aligned grass like structures increasing the surface area about four times the geometrical area. This electrode showed electrochemical activity and was used to selectively detect neurotransmitters dopamine (DA), epinephrine (EP) and norepinephrine (NE) selectively in presence of interfering molecules like ascorbic acid (AA) and uric acie (UA).[7]

1. George M. Whitesides *et al., Angew. Chem. Int. Ed.,* **2007**, 46, 1318 –1320
2. Thiago R. L. C. Paixao *et al., Angew. Chem. Int. Ed.*, **2017**, 56, 15113 –15117
3. Lin Y. *et al., Electroanalysis*, **2010**, 22, 1027−1036.
4. Feng X. *et al., J. Am. Chem. Soc.,* **2012**, 134, 48, 19532–19535
5. Keegan N. *et al., **Nanoscale***, **2014**,**6**, 13613-13622
6. Inal S. *et al., ACS Appl. Nano Mater.*, **2020**, 3, 1166−1174
7. Travas-Sejdic J. *et al., ACS Appl. Mater. Interfaces*, **2018**, 10, 42136−42145