Development of Immunosensor Based on Self Assemble Monolayers of Polymer Metal Nanocomposites for Rapid Quantification of MSG

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BY

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CHAPTER 6

Conclusions and Future Scope

6.1 Conclusion

Working electrode platforms based on chitosan and chitosan-gold nanocomposite networks have been fabricated. An enhancement of four-fold in current has been achieved by incorporating GNP in chitosan, which allowed us to achieve the highest detection sensitivity with the lowest detection limit of 0.1 nM. The functional activity of CS-GNP was further enhanced by EDC-NHS functionalization for selectively incorporating antibodies on the composite surface. Antibodies' interaction with the CS-GNP platform was confirmed through a reduction in electrochemical current. The pH of the electrolyte showed a significant perturbation in the stability of the antibody-functionalized working electrode and the corresponding interaction with MSG. The finding demonstrates the highest electrochemical activity of MSG and antibody interaction at the working electrode at a pH value of 7.2.

The electro-polymerization of aniline monomer with TiO_2 was carried out using cyclic voltammetry, and a fine powder of PANI-TiO_2 nanocomposites was collected. LB monolayer of these nanocomposites was prepared on ITO coated glass electrode. FE-SEM, TEM, and XPS confirmed the presence of TiO_2 at the surface of the PANI-TiO_2 nanocomposite and their LB coating. Further monoclonal antibodies specific to L-glutamic acid were immobilized onto the LB film through an EDC-NHS coupling reaction. The antibodies immobilized electrodes were successively used to quantify MSG ranging from 1 nM to 500 µM in the standard electrolyte. A linear relationship was obtained between the current change and the MSG concentration.

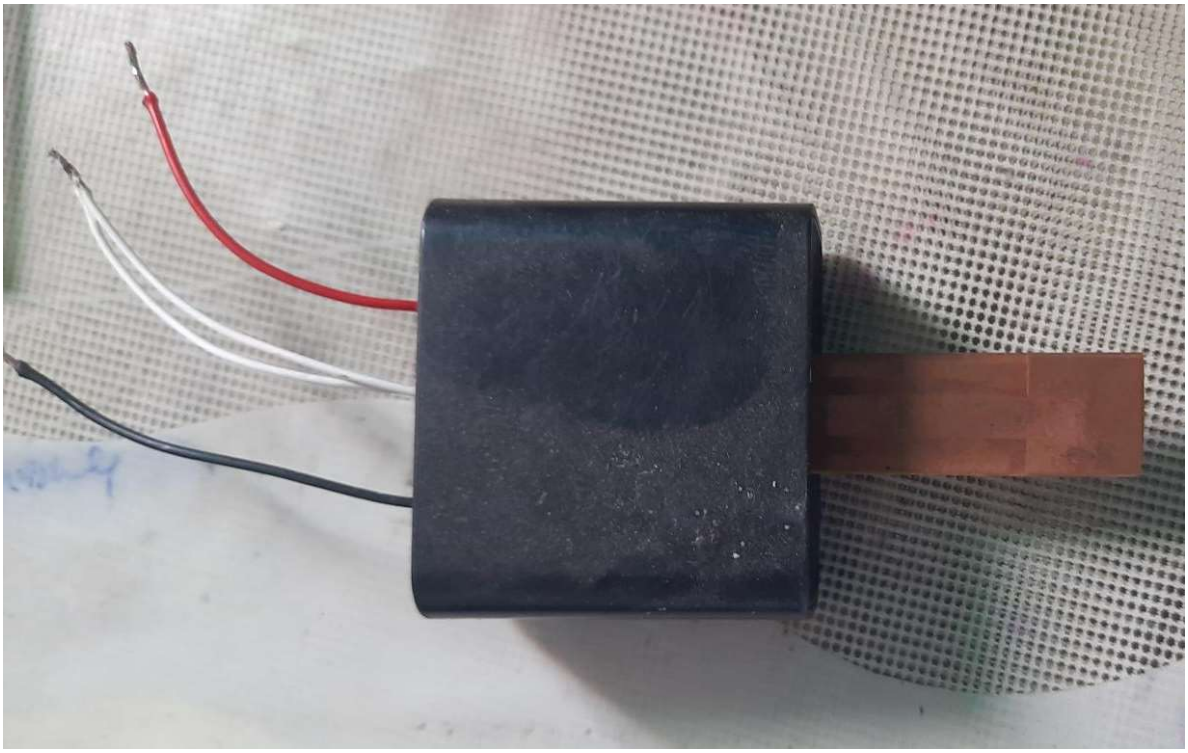

Figure 6.1: *Fabrication of three-electrode system (strip on right side of the voltage converting black color device) by physical patterning for the possible use of different platforms developed in this study as point-of-care devices.*

Electrochemical polymerization of aniline enables the deposition of PANI in the presence of GNP with hydrophobic characteristics. A careful design of strategies enables the dispersion of electrochemically synthesized PANI-GNP nanoparticles of 6 nm diameter in NMP and isopropanol to prepare a floating monolayer on the water for depositing LB film. XPS high-resolution $4f$ of gold peck shows relative increases in proportion Au^{+1} at the LB film surface of PANI-GNP. Further, the electrochemical analysis confirms higher charge transportation and better surface functional capability of these surfaces. LB monolayer is fabricated on the ITO electrode. XRD, TEM, EDAX, and XPS confirmed the presence of GNP at the surface of PANI-TiO_2 nanocomposite and their LB coating. Further monoclonal antibodies specific to L-glutamic acid were immobilized onto the LB film through an amine coupling reaction.

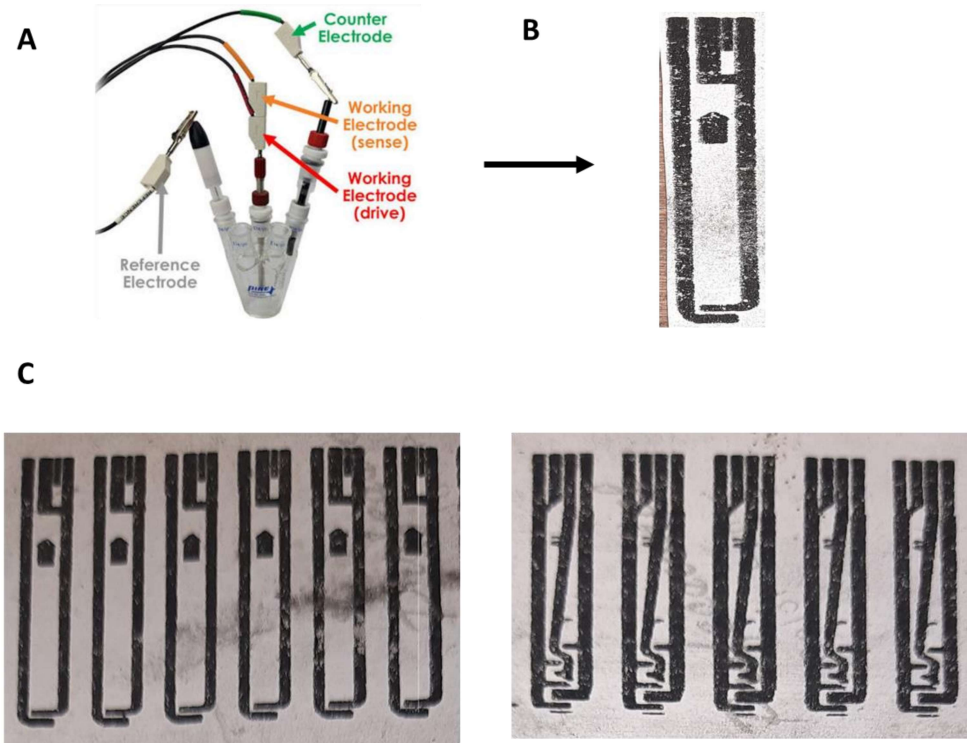

Figure 6.2: *(A) Schematic diagram of proposed point-of-care diagnostic system. (B) Image of electrode fabricated for a point-of-care diagnostic system with the use of reduced graphene oxide conducting ink. (C) Showing different combinations of the conducting ink printed pattern with reduced graphene oxide conducting ink.*

The antibodies immobilized immunosensor were sequentially used to quantify MSG ranging from 1 nM to 10 mM in the standard electrolyte and 1 µM to 1 mM in tomato sauce. A linear relationship was obtained between the current change and the MSG concentration.

6.2 Future Scope

The study outcome of this research from the development of different materials and using them for making different types of platforms for immunosensors have been explored for the detection of MSG in both electrolyte and food samples. A further study was started to make the point-of-care device for this application. This included designing different electrode materials, which were printed on PCB surfaces by having physical patterning. Further work has been done on using different types of conducting ink made of reduced graphene oxides on paper and other surfaces. Details of images of these are shown in **Figure 6.1** and **Figure 6.2**. In the future, the study can be extended to further modify these electrodes, which have been developed for the use of point-of-care devices by integrating the research outcomes of this thesis towards making a fully functional point-of-care diagnostic system.