INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Studies on Polylactic Acid based Nanocomposites for Improved Dispersion and Sensor Applications

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SHORT ABSTRACT

This work mainly addresses the dispersion of filler, graphene into bio-based and biodegradable polymer, Polylactic acid (PLA) and its potential towards sensor applications. Various dispersion techniques such as solvent coating and non-covalent master-batch approaches, were adopted to promote uniform dispersion of graphene in the PLA matrix in case of melt processing. Secondly, the prepared PLA/GR nanocomposites were tested for the detection of different molecules like organic solvents, glucose, glycine and metal ions. Different additives like iron decorated cellulose nanocrystal (Fe-CNC), albumin, ethylenediaminetetraacetic acid (EDTA) and silk nanocrystal (SNC) were used in order to improve the sensitivity of PLA/GR composites towards the targeted electrochemical or biosensing applications. Finally, in order to utilize PLA for vapour sensing, carbon templated magnetic nanoparticles were incorporated into PLA and a 3D printed gas chamber along with interdigital electrode based sensing set up was constructed and applied to test ethanol vapour detection. Thermal stability, dispersion and mechanical properties were found to be improved through solvent coating and master batch approach. Optimum loading was found to be 1.7 wt.% GR, when the impedance was drastically reduced to 10^5 Ω with respect to pure PLA (10^{11} Ω). However, the composite containing 2.5 wt.% GR loading showed the most stable conductivity and was taken as the model composite film, which yielded good sensitivity and high selectivity for ethanol detection. In addition, the composite showed reusability of films for at least five cycles and the results from different composite batches were also found reproducible in nature. Incorporation of iron oxide decorated cellulose nanocrystal (Fe-CNC) has improved the applicability of PLA/GR composite towards detection of ethanol, D-glucose and glycine. In presence of additives like EDTA, Albumin and SNC, I-V characteristics indicated the presence of peak current copper ion for different cases based on the binder. Peak current was found to increase with increasing concentration of copper. It was found that for PLA based magnetic composites, the presence of magnetic field increased the storage modulus and viscosity of the composite melts. Representative materials were tested for ethanol sensing under nitrogen flow environment. Response was found to be increasing within 10 seconds.