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Synthesis and characterization of conductive polymer hydrogels and the investigation of their application as biosensor hybrid for catechol detection

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Hydrogels are materials easily swollen by water, producing three-dimensional cross-linked structures with large surface area. Hydrogels contain interstitial spaces, permitting transport of small molecules. Conductive polymers hydrogels are highly preferable due to their mechanical and swelling properties, additional to specific electron transport properties of simple conductive polymers. Hydrogels of polyaniline (PANI), polyindole (PIN) and poly (indole-5-carboxylic acid) (PIN5COOH) were chemically synthesized with poly styrene sulfonate at pH=5. Infrared spectroscopy (IR) was employed to characterize the synthesized hydrogels. Spectra of the gels revealed intense bands from water and poly styrene sulfonate. Further characterization was carried out using Raman spectroscopy at 455, 633 and 1064 nm excitation lines. The spectra of the PANI gel revealed bands corresponding to its conductive and bipolaronic forms. The spectra obtained for PIN gel showed bands characterizing hetero aromatic rings and C=N bond modes which are in agreement with its structure. Spectra of the PIN5COOH gel exhibited bands indicating carboxylic acid groups, in addition to bands seen in the PIN gel spectra. Raman spectra of electrochemically deposited films of the polymers were also obtained, confirming the bands that were observed in the gel spectra. Cyclic voltammograms of the gels validated the redox properties of all three conductive polymers gels. Morphological studies were performed using atomic force microscopy (AFM) and scanning electron microscopy (SEM), suggesting the formation of small polymer spheres bound to each other. Conductive polymer hydrogels add high conductivity and sensitivity, contributing to sensor design possibilities. Preliminary application of PANI gel as substrate for tyrosinase was done for electrochemical detection of catechol. The sensitivity of the PANI gel-based biosensor (1080 μA M^{-1}) was much greater when compared to the biosensor based on PANI film (103 μA M-1). Catechol detection was also performed using PANI gel in conjunction with gold nanoparticles, which increased the electrode's sensitivity to 2370 μA M^{-1}.

Biography

Ezer Castillo is an under-graduate Chemistry student at Adelphi University, NY (USA). He currently works as a Research Assistant in Dr. Widera-Kalinowska's laboratory and also spent the summer conducting research at University of Warsaw, Poland through the McDonnel Research Fellowship, developing polymer hydrogels for sensor application in collaboration with Dr. Barbara Pałys.

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