MoS_2 and PAni nanocomposite thin films prepared by liquid-liquid interfacial route (LLIR): Synthesis, Characterization and electrochemical studies

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Given the rapid development and evolution of technology over the past decades, the demand for materials to be employed in the construction of electronic devices has risen massively, which spiked interest in the development of new, more sustainable and readily available materials, to supply such demand. Molybdenum disulfide (MoS_2) is an example of a material that has been heavily studied due to its natural abundance, low toxicity and promising optical and electrical properties [1]. Alongside, conjugated conducting polymers, such as Polyaniline (PAni), have been investigated for similar applications, since this class of materials also presents desirable characteristics for the development of eco-friendly and sustainable electronic devices [2]. Therefore, this work deals with the preparation of thin films of MoS_2/PAni nanocomposites in a toluene/aqueous acid solution interface, via liquid-liquid interfacial route (LLIR) [3], and a study of the effects provided by varying reaction conditions, such as precursors amount and pH of the aqueous phase. These films were characterized by UV-Vis Spectroscopy, X-ray Diffractometry (XRD), Scanning Electron Microscopy (SEM), Fourier-Transform Infrared Spectroscopic (FTIR), Raman Spectroscopy, and their electrochemical behavior was also investigated by various techniques. Results show that each reactional condition generates slightly different films. Visually, films prepared at lower pH values seem thicker and more intense in color, despite still being transparent. UV-Vis spectra show that films synthesized at higher pHs present lower quantities of delocalized polarons, which indicates lower doping of the polymer, and this also happens with the decrease of the monomer quantity. FTIR and Raman spectra don't seem to indicate significant changes when the monomer quantity is varied, though it becomes evident through these analyses that higher pHs generate a more planar polymer. Electron Microscopy analyses show that variation of monomer quantity also didn't give rise to much difference regarding morphology of the films, while pH changes did. The morphology of films obtained at lower pHs are comprised of islands of polymer covered in MoS_2; In contrast, higher pHs generate a more spread-out polymer base, with regions of concentrated MoS_2 flakes. Initial electrochemical studies reveal that decreasing the amount of monomer increases the electrochemical stability of the emeraldine Salt (ES) form of PAni, and that the presence of the MoS_2 elevates the composite's conductivity. The effect of pH is also evident in the electrochemical behaviors, where higher pHs result in less conducting films, where the ES form is generally less stable, and the presence of the MoS_2 appears to modify the composite's electrochemical behavior to a smaller degree, probably due to it being more isolated in these cases, as remarked in the SEM analyses. Furthermore, the composites containing the smallest amount of polymer present a new faradaic process, non-existing in any of the other composite films obtained. Lastly, these nanocomposites show promising results for application in supercapacitor devices, while other possible applications are still under investigation.

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