Films of Nanocomposites made from 2D Materials and Conductive Polymers

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INTRODUCTION

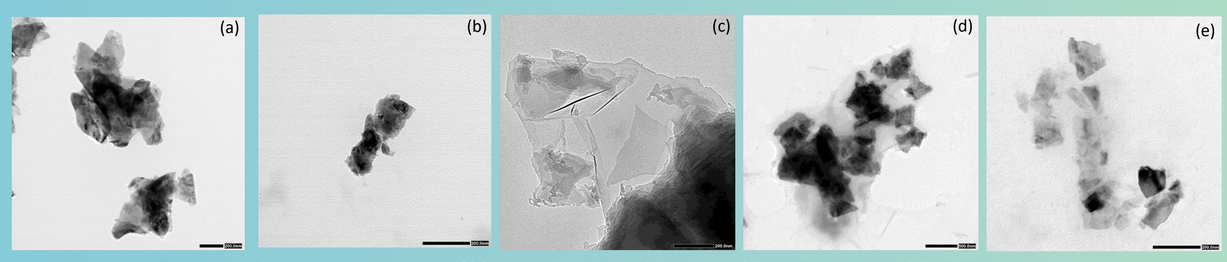
In organic electronics, nanocomposites formed from two-dimensional materials and conductive polymers show great promise due to their electrical and morphological properties.[1] Within the class of 2D materials, metal dichalcogenides have a layered structure, such as molybdenum disulfide (MoS_2) and tungsten diselenide (WSe_2), which have layers, held together by weak van der Waals interactions and act as indirect bandgap semiconductors.[1-3] In this first structure, each Mo atom is sandwiched between two layers of S atoms, forming strong Mo−S covalent bonds, with the Mo atoms occupying an intermediate plane within the layer, similar to what occurs in WSe_2.[3] In order to evaluate the electrical, spectroscopic, and morphological properties of nanocomposites consisting of MoS_2/WSe_2 and PEDOT:PSS films were produced in different solvents and with varying 2D material/polymer ratios, to enable comparison with the results obtained for pure polymer.

EXPERIMENTAL

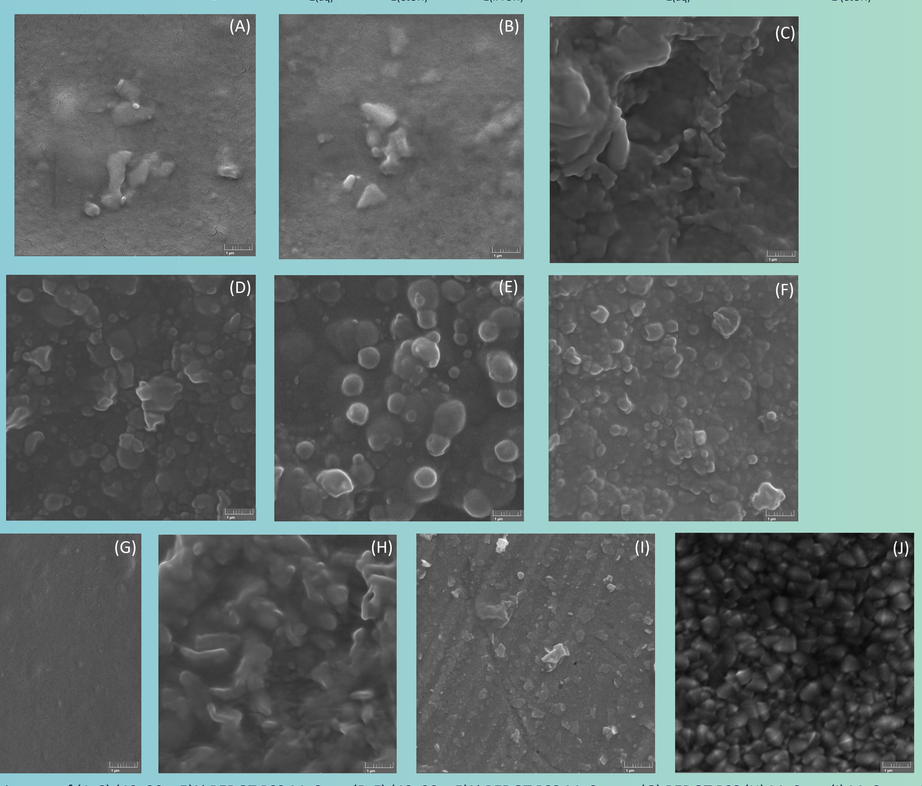
The polymer and the 2D material were mixed in diffent percentages, and the solvents used were water, ethyl alcohol and isopropyl alcohol. The polymer nanocomposite films were characterized using two-point conductivity measurements, Raman spectroscopy, scanning electron microscopy, and transmission electron microscopy, as these techniques are used in the electrical, structural, and morphological analysis of polymers and nanocomposites. Electrical conductivity was calculated from the i-V measurements using the two-point method and the film dimensions.

RESULTS AND DISCUSSION

Morphology



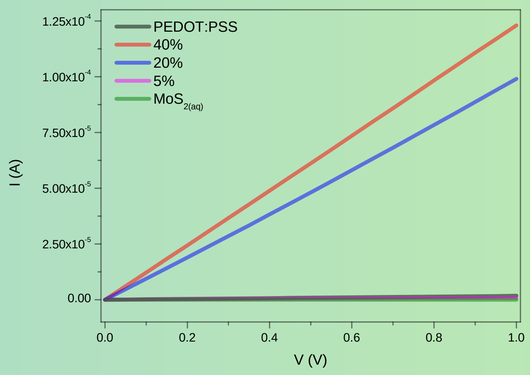
Transmission Electron Microscopy images of (a) $MoS_{2(aq)}$ (b) $MoS_{2(etOH)}$ (c) $WSe_{2(iPrOH)}$ (d) PEDOT:PSS- $MoS_{2(aq)}$ (e) PEDOT:PSS- $MoS_{2\ (etOH)}$.

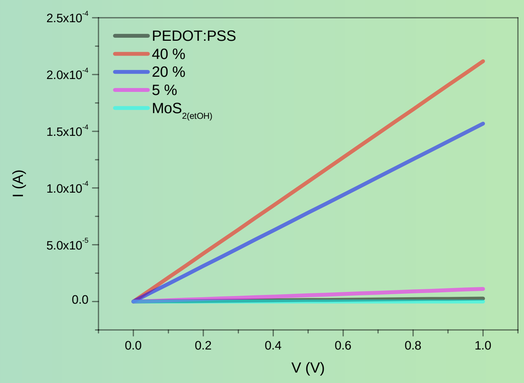


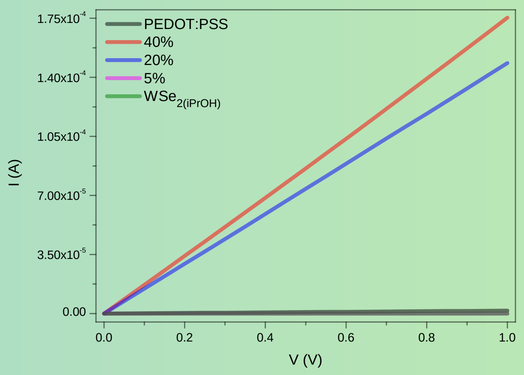
Scanning Electron Microscopy images of (A-C) (40, 20 e 5)% PEDOT:PSS-$MoS_{2(aq)}$ (D-F) (40, 20 e 5)% PEDOT:PSS-$MoS_{2\ (etOH)}$ (G) PEDOT:PSS (H) $MoS_{2(aq)}$ (I) $MoS_{2(etOH)}$ (H) $WSe_{2(iPrOH)}$

RESULTS AND DISCUSSION

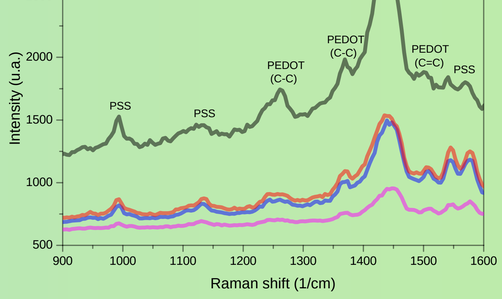
Electrical Properties

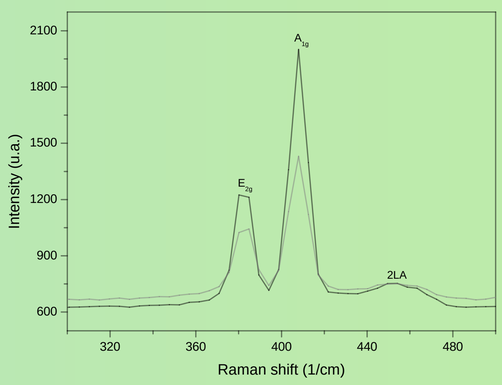




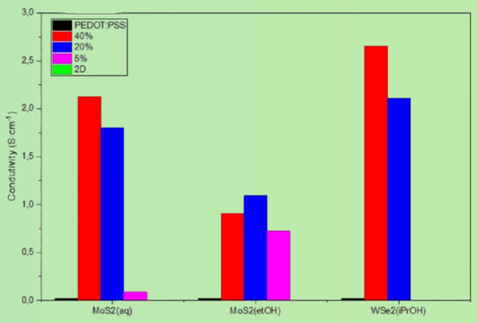


Raman Spectroscopy





Electrical Conductivity



CONCLUSION

The nanocomposites showed an improvement of one order of magnitude compared to the commercial Polymer. In the Raman spectra, it was possible to identify the vibrational modes, confirming the presence of both phases. Morphological analysis revealed distinct behavior among MoS_2 samples prepared with different solvents, indicating that the nature of the solvent has a significant influence on the formation and microstructural organization of the nanocomposite films.

REFERENCES

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