Free-Standing Composite Films Based on Thiol-Ene and PEDOT: PSS Layers for Optoelectronic Applications

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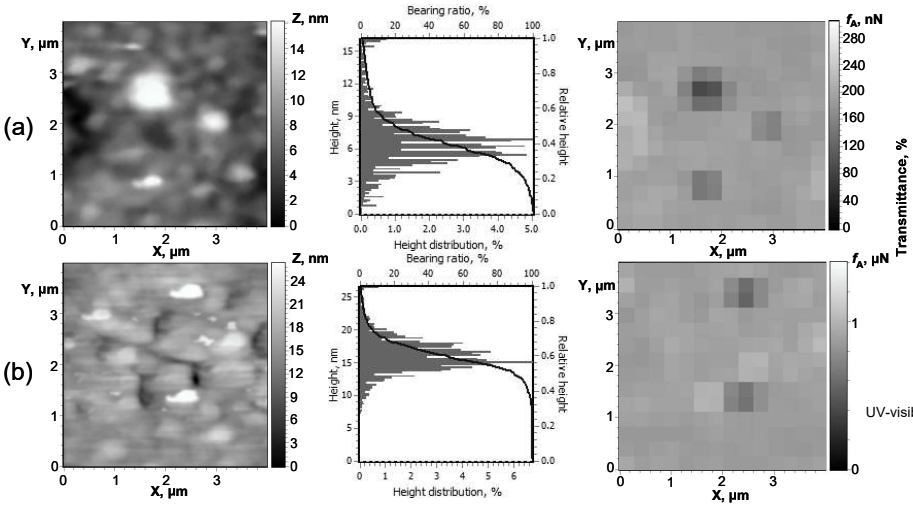
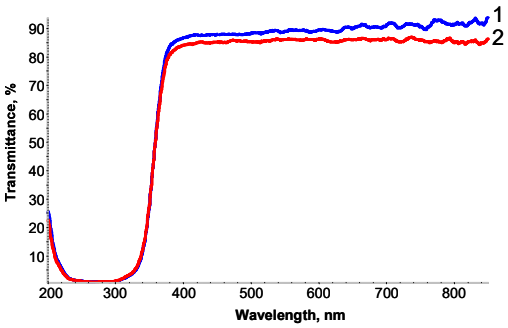
ABSTRACT

Free-standing composite films were fabricated by combining the plane parallel layers of thiol-ene based on pentaerythritol tetrakis(3-mercaptopropionate)-1,3,5-triallyl-1,3,5-triazine -2,4,6(1H,3H,5H)-trione (PETMP-TTT) UV curable polymer and poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS) conductive polymer. A systematic analysis was performed with the focus on mechanical performance of the free-standing composite films. The PE-DOT:PSS/PETMP-TTT composite exhibited higher values of adhesion force compared to the free-standing PETMP-TTT film due to hydrophilic nature of the PEDOT:PSS layer. The composite was found to be highly transparent in the range of 380–800 nm. The Young's modulus and tensile strength of PETMP-TTT were found to be 3.6 - 0.4 GPa and 19 - 3 MPa, while for PE-DOT:PSS/PETMP-TTT – 3.5 - 0.3 GPa and 20 - 3 MPa, respectively. The sheet resistance values of the PEDOT:PSS layer in the composite film were found to be highly stable after a number of bending iterations with slight increase in sheet resistance from 108 to 118 ± 2 Ω/□. The resultant PEDOT:PSS/PETMP-TTT composite can be further used in optoelectronic applications.

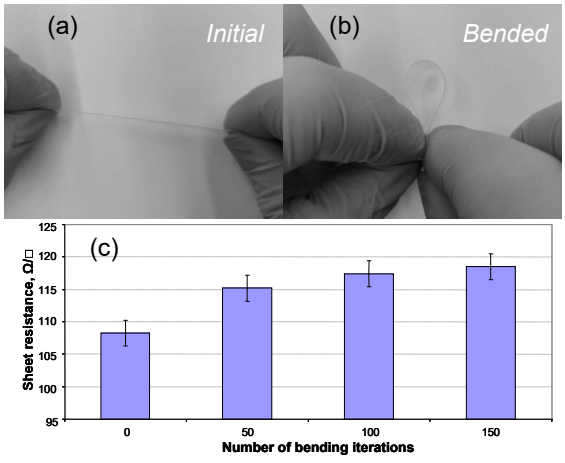
RESULTS



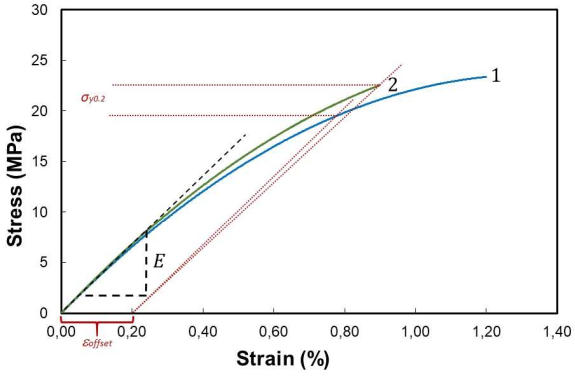
Atomic force microscopy (AFM) surface topography, normalized height distribution histograms and bearing ratio curves as well as adhesion mapping images of PETMP-TTT (**a**) and PEDOT:PSS/PETMP-TTT (**b**).



UV-visible transmission spectra of PETMP-TTT (**1**) and PEDOT:PSS/PETMP-TTT (**2**).



Bending test: free-standing PEDOT:PSS/PETMP-TTT composite film at the initial (**a**) and bended (**b**) position, sheet resistance values of the PEDOT:PSS layer after a number of bending iterations (**c**).



Stress-strain curves of PEDOT:PSS/PETMP-TTT (**1**) and PETMP-TTT (**2**). The characteristic dashed tangential lines represent determination of experimental Young's modulus (*E*) for the PETMP-TTT free-standing film. The intersection of the dotted lines with the experimental curve at 0.2 % strain offset provides the yield stress ($\sigma_{y0.2}$)

CONCLUSIONS

Free-standing composite films were fabricated by combining the PETMP-TTT and PEDOT:PSS layers. Quantitative morphological evaluation was performed giving insight on PETMP-TTT and PEDOT:PSS/PETMP-TTT surface topography, roughness and adhesion force distribution that have been estimated making use of AFM. The fabricated composite was found to be highly transparent for visible light. Mechanical properties (i.e. Young's modulus, tensile strength and indentation hardness) of the PEDOT:PSS/PETMP-TTT were tested providing a first characterization of such composite material for its exploitation in optoelectronic applications. Electrical properties and their dependence on the number of bending iterations have been also studied by repeating sheet resistance measurements with a four point probe technique before and after bending the composite multiple times. It was demonstrated that the electrical properties of PEDOT:PSS/PETMP-TTT composite are highly stable.

ACKNOWLEDGEMENTS

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