Structural and optical properties of PEDOT:PSS Incorporated by Gold and Silver Nanoparticles for organic solar cells

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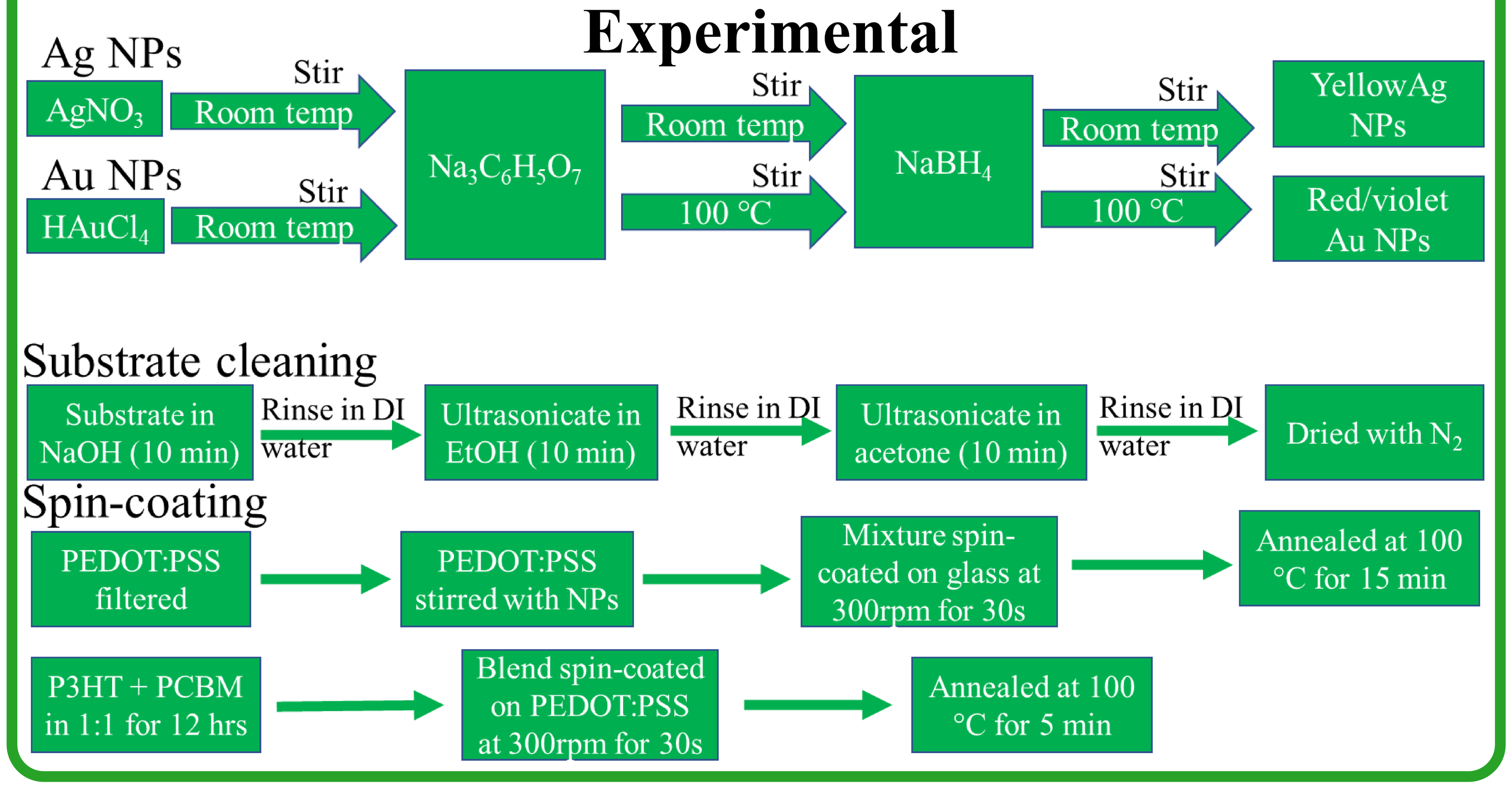
Introduction

- Metal-polymer nanocomposites are metallic nanoparticles (NPs) embedded in a conducting polymer matrix [1].
- They have gotten a lot of attention in the recent two decades because of their tuneable magnetic, mechanical, electrical, and optical properties.
- PEDOT:PSS is a conductive polymer with a good work function and surface roughness benefits that is often employed as a buffer layer in organic solar cells between the anodic electrode and the organic photoactive layer [2].
- Researchers discovered that incorporating Au and Ag NPs into PEDOT: PSS sheets improves the composite's visible spectrum absorption due to localized surface plasmon resonance (LSPR) [3].
- It has also been observed that incorporating Au and Ag NPs into PEDOT:PSS can improve the conductivity of the material while simultaneously improving the surface roughness
- In this study, colloidal Au and Ag NPs were synthesised and hybrid Au and Ag NP-PEDOT:PSS thin films were created.

Experimental



Results and Discussion

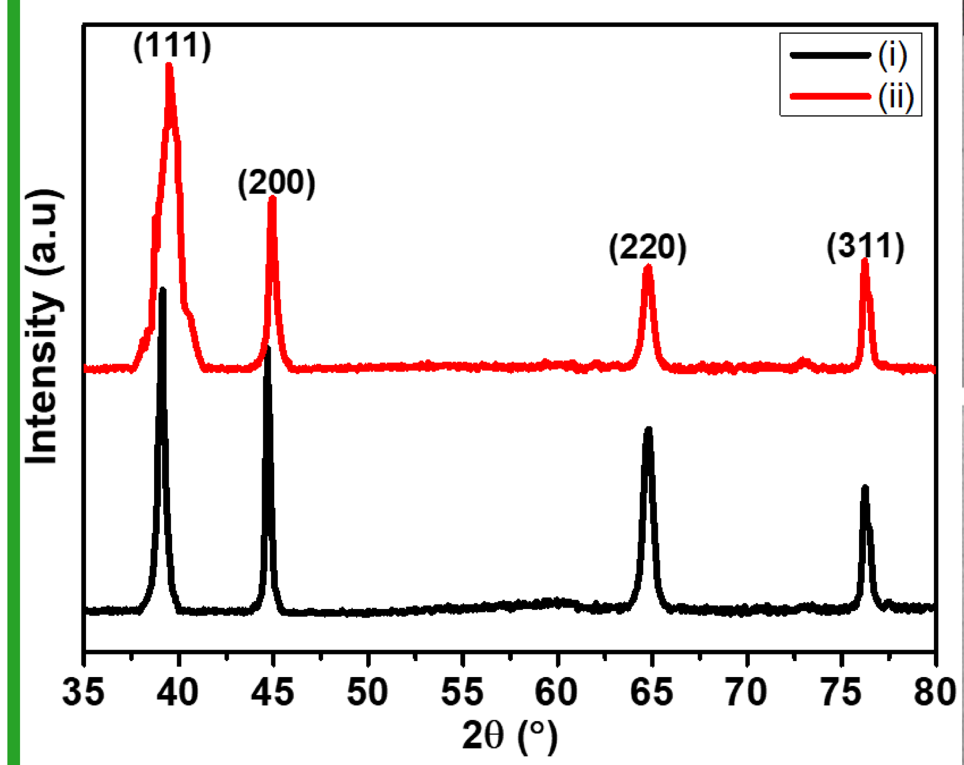


Figure 1: X-ray diffraction patterns of citrate capped (i) gold nanoparticles and (ii) silver nanoparticles.

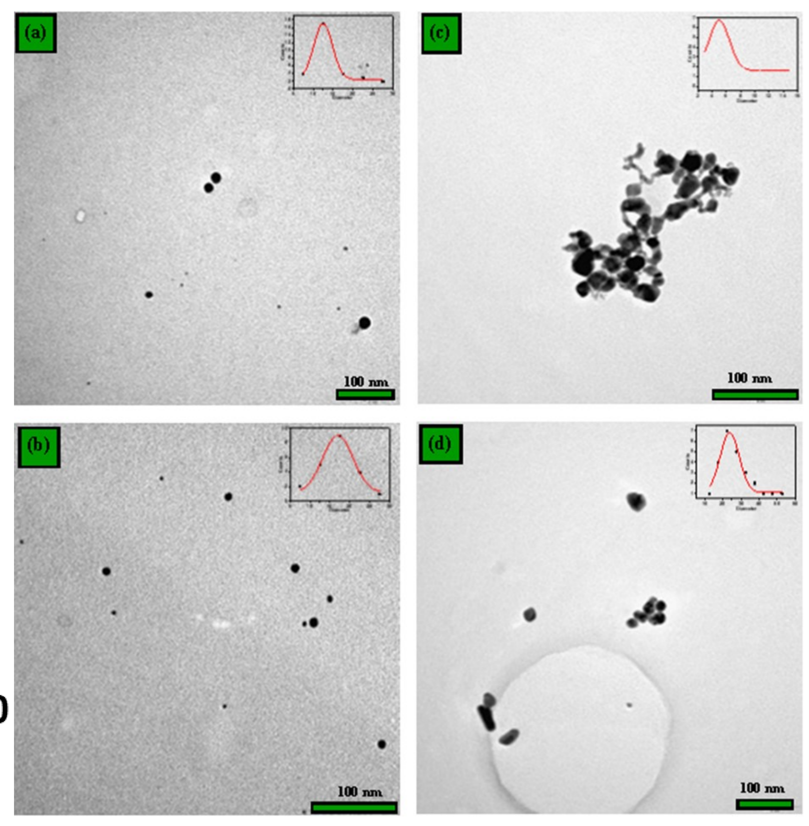


Figure 2: TEM of Ag NPs with (a) 10 mM, (b) 5 mM $NaBH_4$ and Au NPs with (c) 0.1 M $NaBH_4$ and (d) without $NaBH_4$

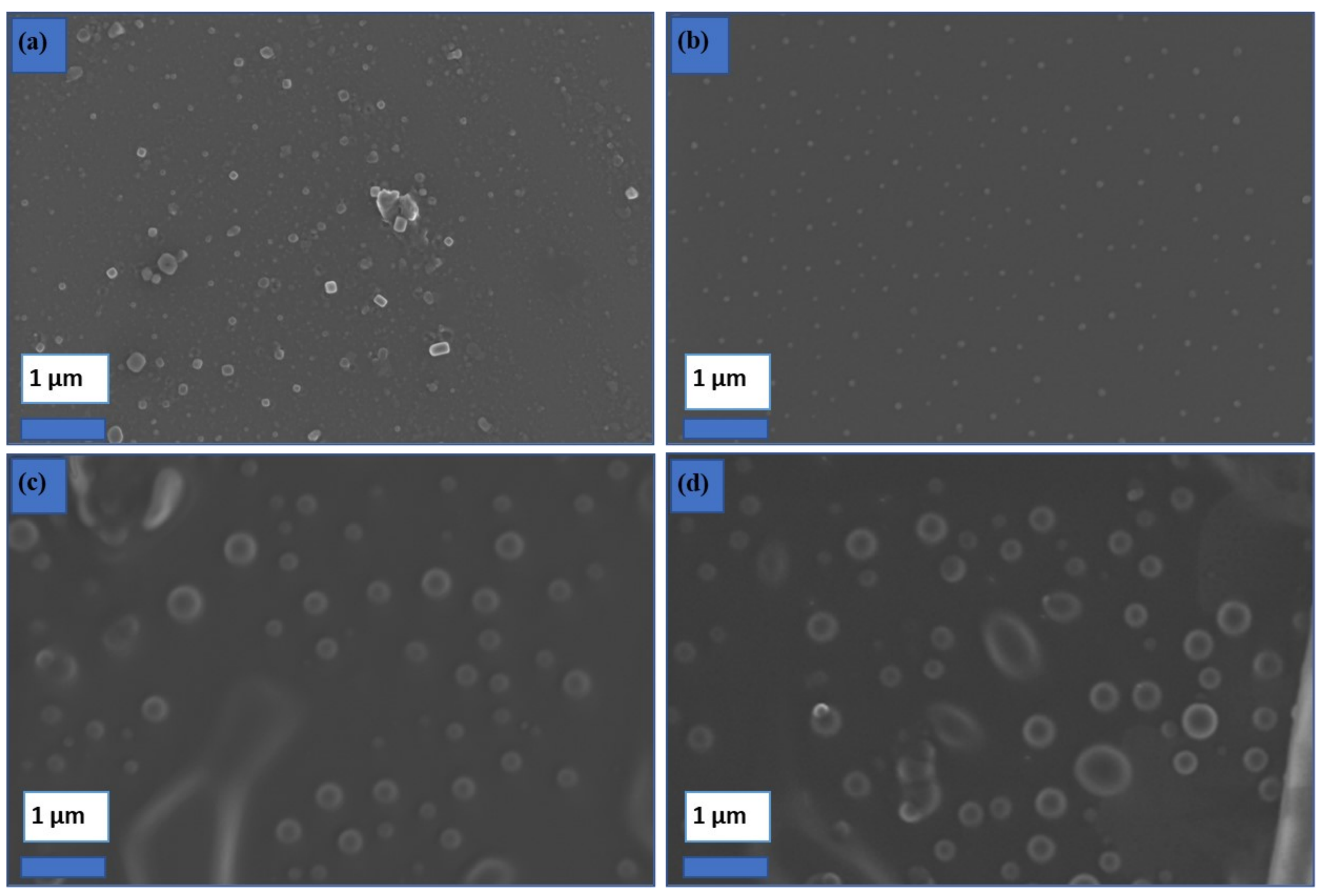


Figure 3: Scanning electron microscopy of (a) P3HT:PCBM, (b) PEDOT: PSS and (c) PEDOT: PSS:AuNPs|P3HT:PCBM (d) PEDOT:PSS:AgNPs| P3HT:PCBM

Results and Discussion

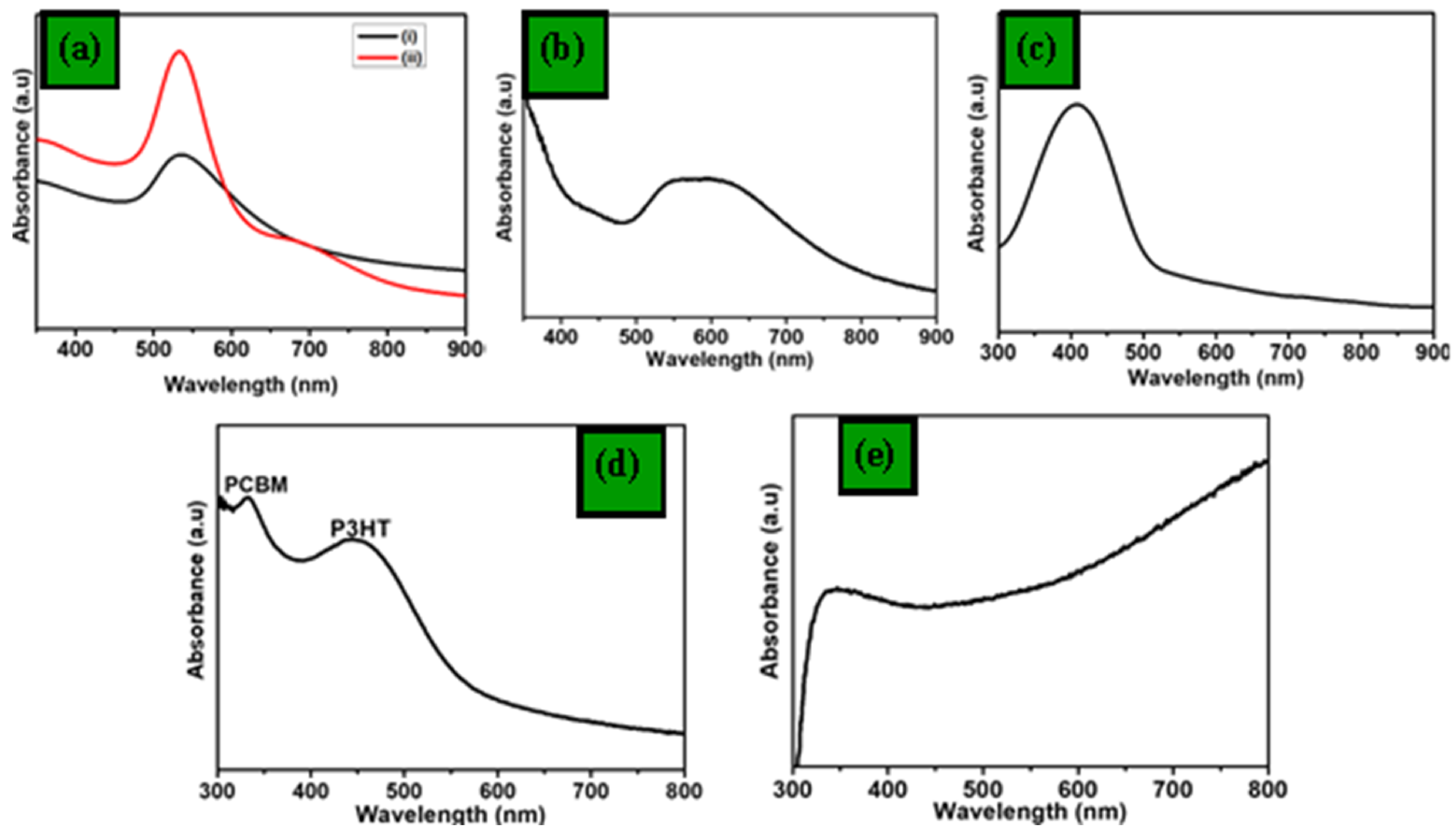


Figure 4: UV/Vis spectra of (a) Au NPs (i) 0.1 M $NaBH_4$ and (ii) without $NaBH_4$, Ag NPs, with (b) 10 mM, (c) 5 mM $NaBH_4$, (d) PEDOT:PSS and (d) P3HT:PCBM

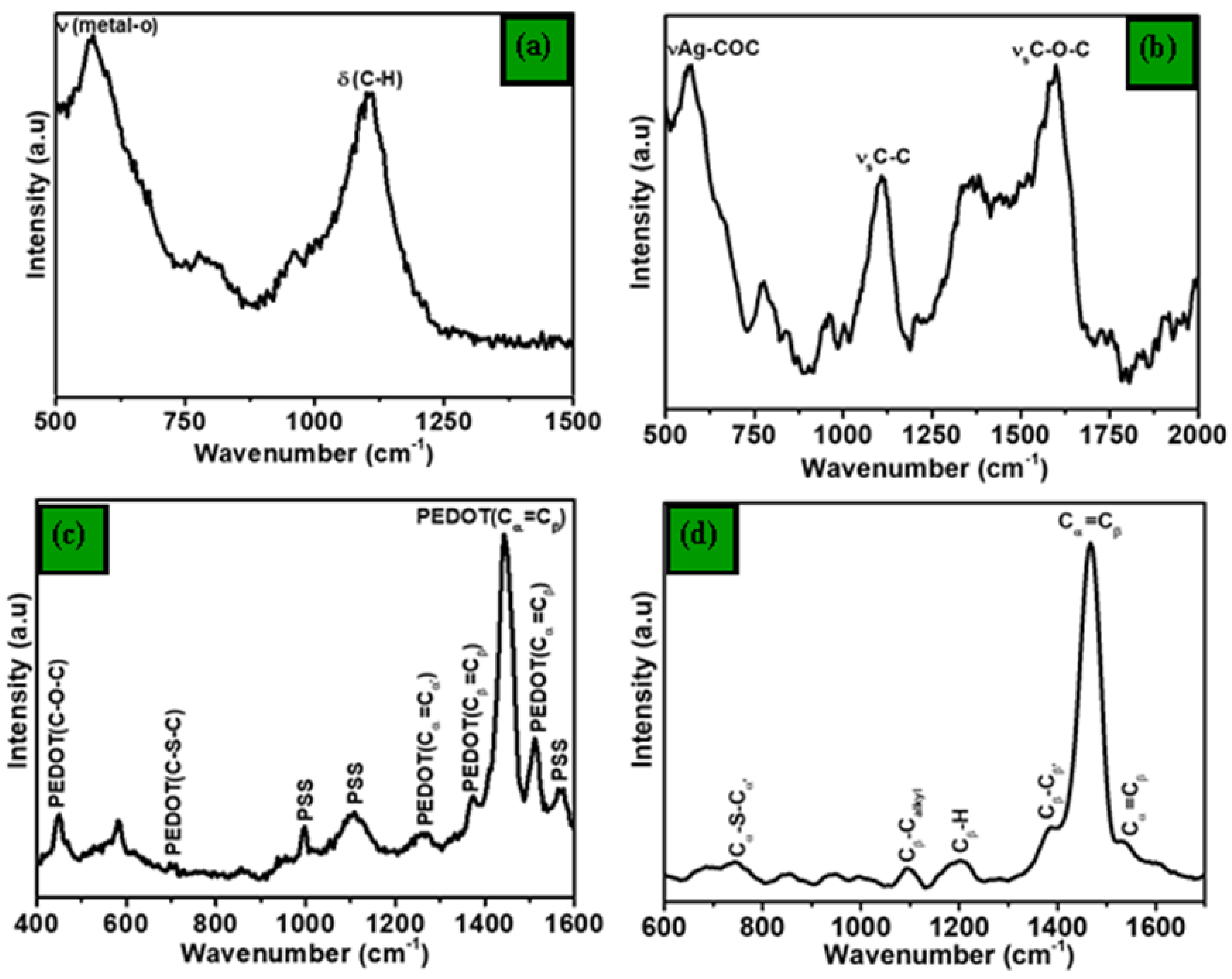


Figure 5: Raman spectrum of (a) Au NPs, (b) Ag NPs, (c) PEDOT:PSS and (d) P3HT:PCBM

Conclusion

- In this study, the plasmonic effect of Au and Ag NPs were investigated.
- The NPs were successfully synthesized using chemical reduction in which $HAuCl_3$ and $AgNO_3$ were capped separately with trisodium citrate and reduced to Au and Ag respectively using $NaBH_4$ and heat.
- TEM analysis has confirmed the spherical shapes of NPs with average grain sizes of 23.7±0.5 for Au NPs and 5.0±1.2 nm for Ag NPs. FESEM revealed the diameter of PEDOT:PSS NPs ranging from 50 to 60 nm.
- The UV/Vis spectra for NPs and P3HT had peaks in the visible region whereas PCBM and PEDOT:PSS had peaks in UV region.
- The FCC crystal structures for Au and Ag NPs were confirmed by XRD with (111), (200), (220) and (311) planes. The stretching modes of the NPs were confirmed by Raman spectroscopy.
- High concentration of $NaBH_4$ increases the grain size of NPs. From this study, NPs can be used to improve PCE of OSCs by reducing charge recombination.
- More studies can be done by synthesising different shapes and sizes of plasmonic NPs to be incorporated inside PEDOT:PSS.

References

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