Supporting Information

One-pot Synthesis of Silver Nanoparticles decorated Poly(3,4-ethylenedioxythiophene) Nanotubes for Chemical Sensor Application

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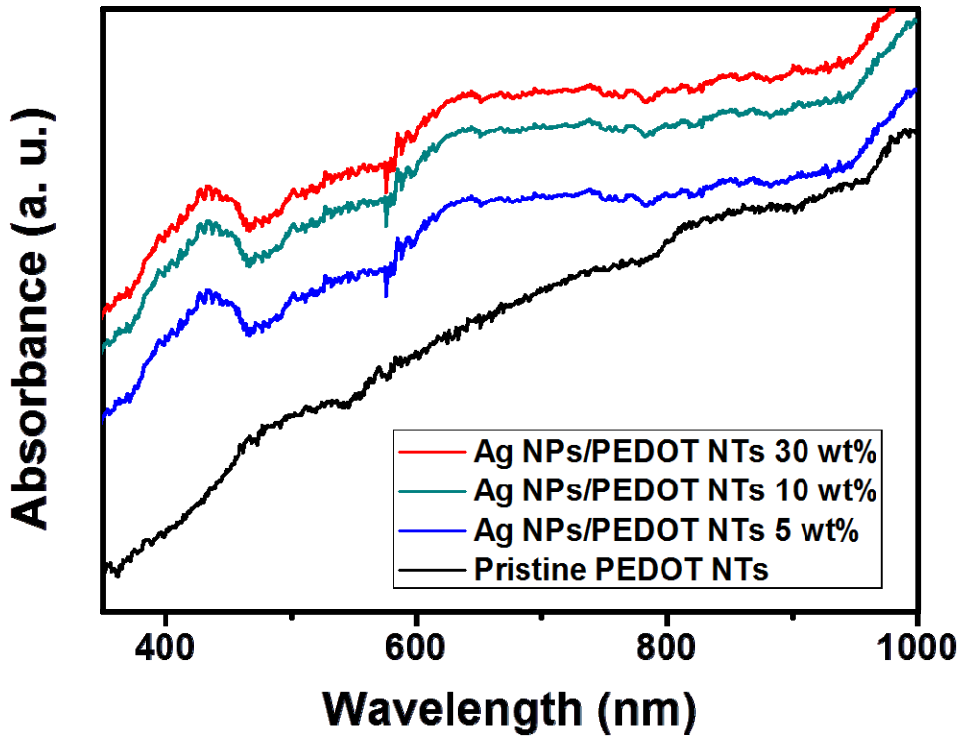
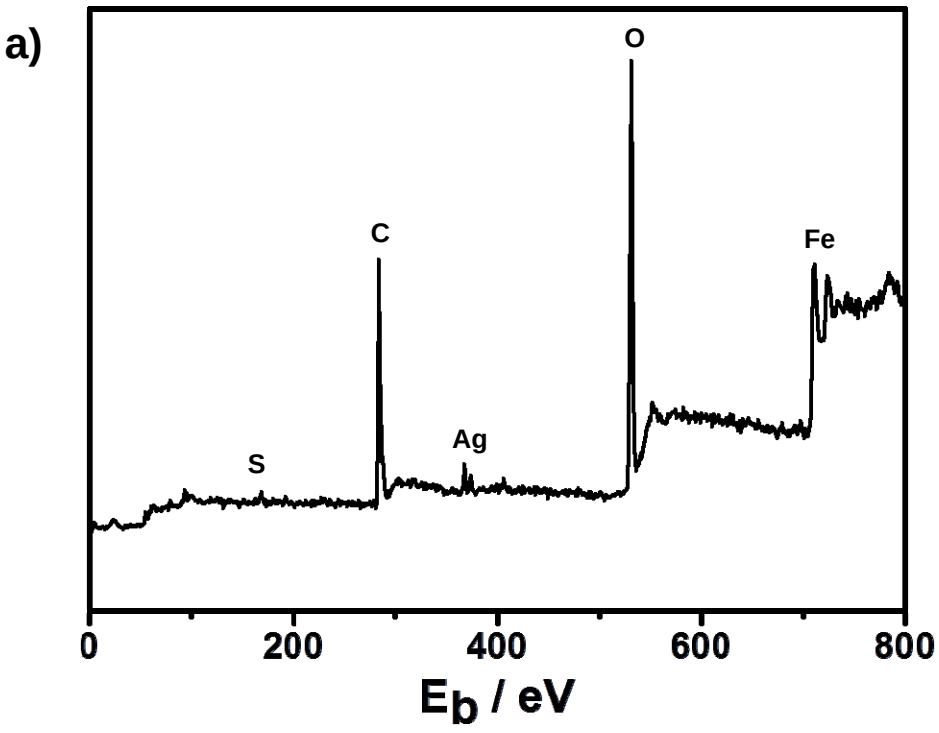
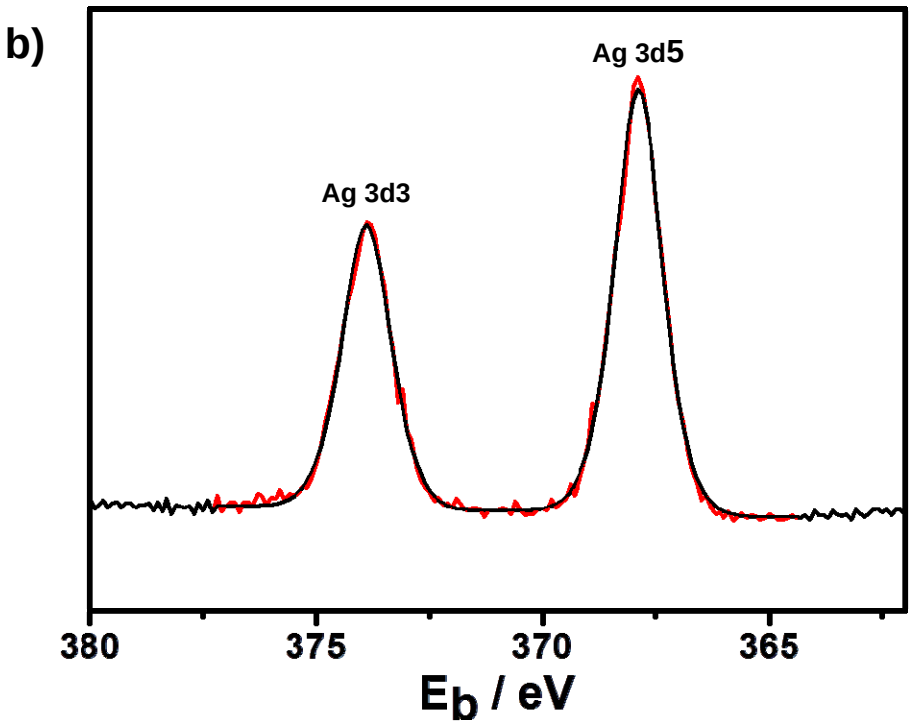


Figure S1. UV-vis spectra of pristine PEDOT NTs and Ag NPs/PEDOT NTs as increasing $AgNO_3$ concentration.

In order to investigate the oxidation level of PEDOT NTs, pristine PEDOT NTs and Ag NPs/PEDOT NTs were further characterized by UV-vis-NIR spectroscopy. (Figure S1) It is known that chemical p type doping gives rise to a multistage oxidation reaction of polymer chains, leading to an improved conductivity through generation of charge carriers, such as polarons or bipolarons. The spectra of pristine PEDOT NTs and Ag NPs/PEDOT NTs exhibited a strong absorption band above 600 nm, indicating that most of polymer structure is in a bipolarnoic state, which means the formation of a sufficient number of charge carriers. [1,2] The Ag NPs/PEDOT NTs exhibited a stronger absorption band in NIR region than pristine PEDOT NTs ; this is indicative of the presence of the metallic state. [3] Therefore, the Ag NPs/PEDOT NTs were in the higher oxidation level, followed by the pristine PEDOT

NTs. This trend is coincided with that of the conductivity of the nanomaterials. Additionally, absorption peak at 420 nm in the Ag NPs/PEDOT NTs correspond to the surface plasma resonance of silver NPs. [4] As shown in Figure S1, the oxidation level is highly dependent on the concentration of $AgNO_3$ under 30 % (wt/wt). It is postulated that the number of silver ions play an crucial role in determining the oxidation level because PEDOT NTs can be oxidized during the reduction of silver ions to silver NPs. However, the increment of conductivity slowly decreased over 30 % (wt/wt) because PEDOT NTs can only reduce limited amounts of silver ions to silver NPs. Above 30 % (wt/wt) $AgNO_3$ concentration, the conductivity does not increase as increasing $AgNO_3$ concentrations. Additionally, it is not observed that any conductive pathways were constructed by connecting each silver NPs as shown in TEM images. Therefore, the enhancement in conductivity is highly dependent on the oxidation level of PEDOT NTs.





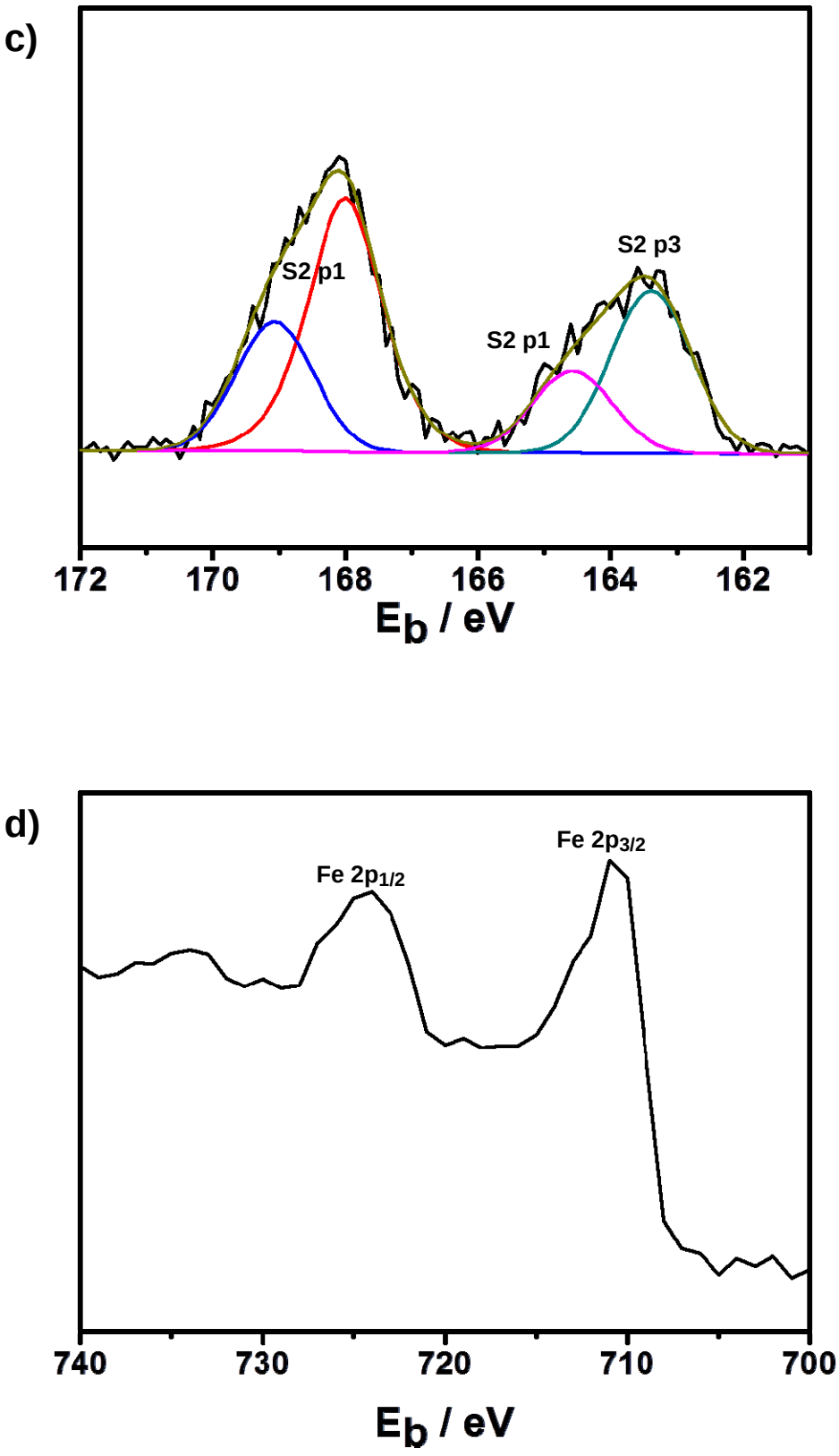


Figure S2. The XPS spectra of a) Ag NPs/PEDOT NTs, b) Ag, c) S and d) Fe.

References

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(3) Y. Chang, K. Lee, R. Kiebooms, A. Aleshin, A. J. Heeger, *Synth. Met.*, **1999**, *105*, 203.

(4) T. C. Deivaraj, N. L. Lala, and J. Y. Lee, *J. Colloid Interface Sci.*, **2005**, *289*, 402.