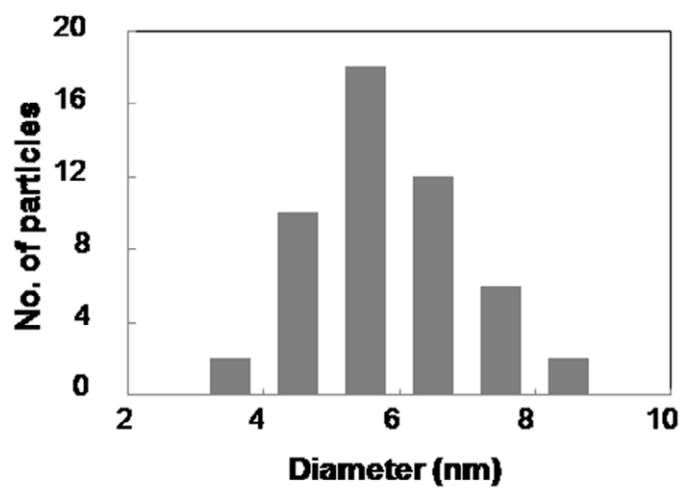


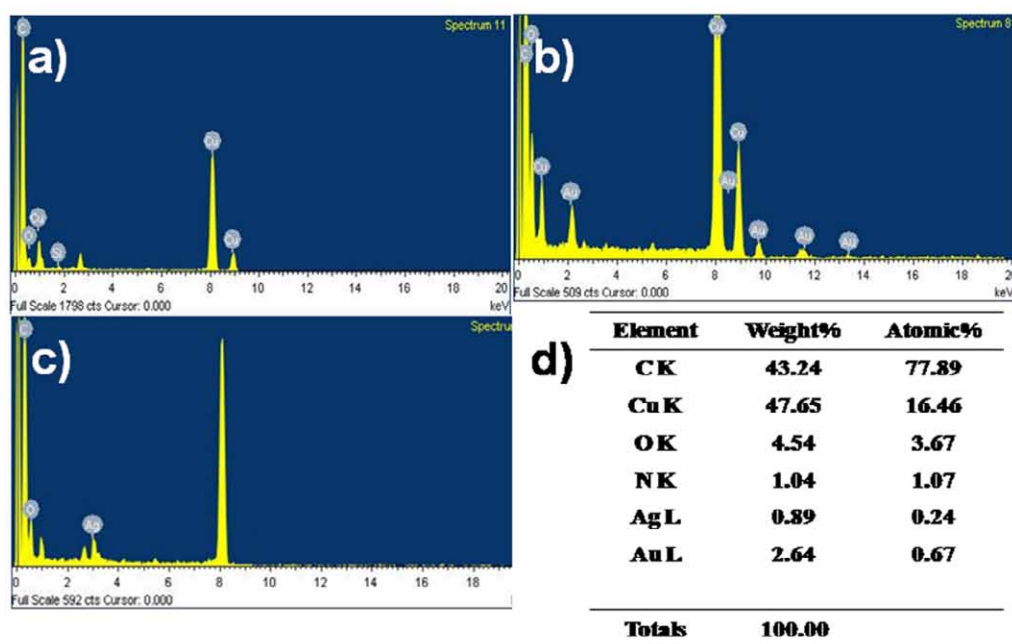
# Supplementary Information

## Free-Standing Polymer Nanoactuators, Nanoshutters, and Nanofilters

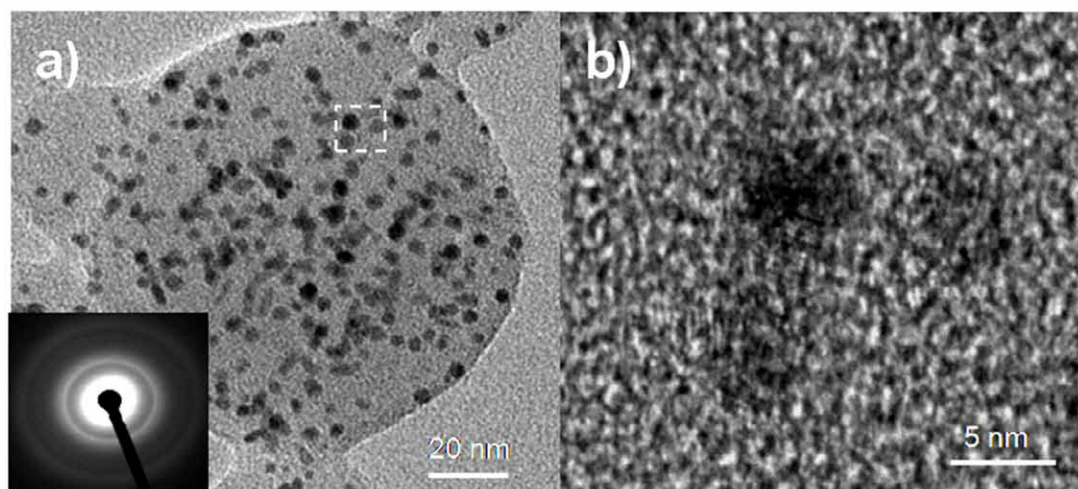
*Md. Shahinul Islam<sup>ab</sup>, Won San Choi<sup>\*c</sup>, Ha-Jin Lee<sup>\*a</sup>, Young Boo Lee<sup>a</sup>, and Il Cheol Jeon<sup>b</sup>*



**Fig. S1** Size distribution data of Au(75%)/Ag(25%) bimetallic NPs within the PECs. Average diameter of NPs was found to be  $6\pm 1$  nm, which was calculated from 50 particles.



**Fig. S2** EDX data of a) bare PECs, b) Au-PECs, c) Ag-PECs, and d) Au(75%)/Ag(25%)-PECs.



**Fig. S3** a) TEM image of Au(75%)/Ag(25%) alloy NP-PECs and its selected area electron diffraction (SAED) in the inset, b) HR-TEM image of three alloy particles observed in a lattice imaging.

The shape of the NPs with an average size of 6 nm was almost spherical, and the NPs of ~10 nm in size came from the aggregation tendency of pure NPs.<sup>[1]</sup> Usually, the core-shell-typed bimetallic NPs composed of Au and Ag showed an apparent electron density banding with a darker Au region and a lighter Ag region.<sup>[2]</sup> However, the TEM analysis showed that most of the NPs exhibited virtually uniform electron density except for the overlapped particles (Figure S2a). Moreover, the crystal lattice oriented with a certain direction that is not observed in the core-shell NPs that was directly seen (Figure S2b).

[1] H. Xu, K. S. Suslick, *ACS Nano*. **2010**, *4*, 3209.

[2] T. Som, B. Karmakar, *Nano Res.* **2009**, *2*, 607.

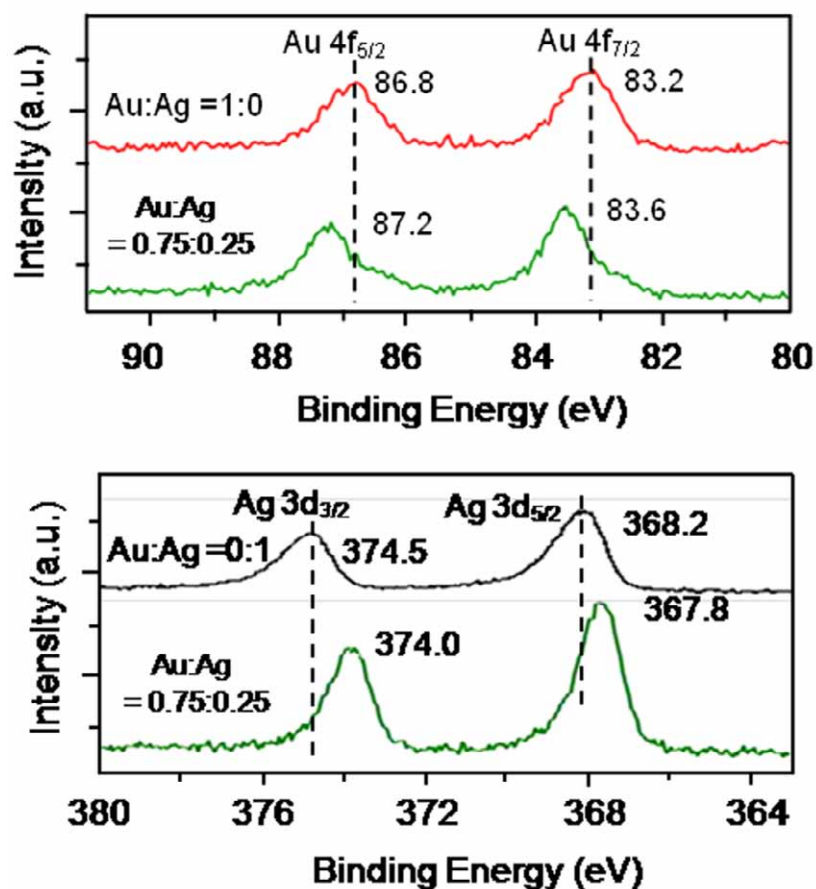
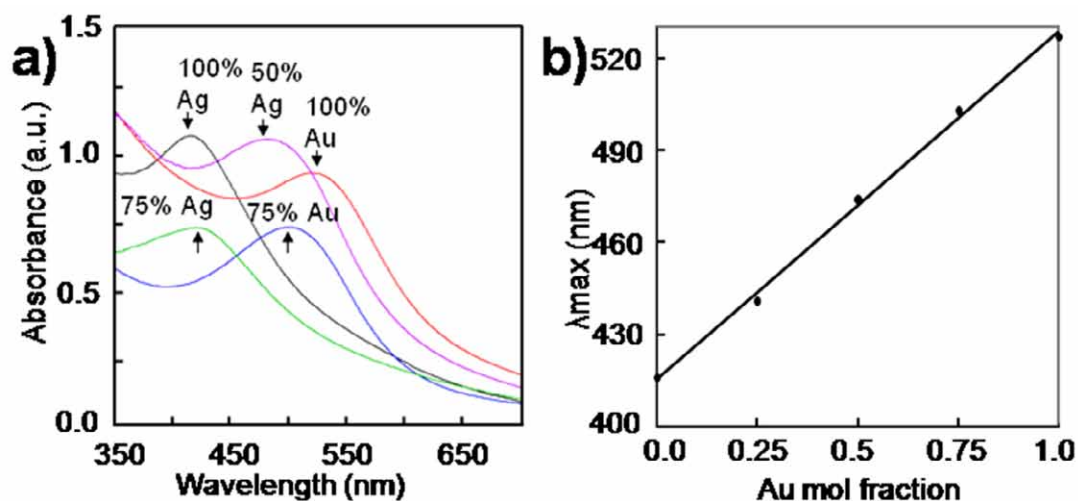


Fig. S4 a) XPS data of Au-PECs (red), Ag-PECs (black) and Au(75%)/Ag(25%)-PECs (green).

To further identify the state of Au/Ag NPs within the PECs, an XPS characterisation was carried out with pure Au (100%), pure Ag (100%), and Au(75%)/Ag(25%) NPs within the PECs (Figure S3). For Au(100%)-PECs, the Au 4f<sub>7/2</sub> and Au 4f<sub>5/2</sub> peaks appeared at 83.2 eV and 86.8 eV, respectively, indicating metallic Au.<sup>[1]</sup> For Ag(100%)-PECs, the Ag 3d<sub>3/2</sub> and Ag 3d<sub>5/2</sub> peaks appeared at 374.5 eV and 368.2 eV, respectively, indicating metallic Ag.<sup>[1]</sup> For Au(75%)/Ag(25%)-PECs, the Au 4f peaks appeared at 83.6 eV and 87.2 eV, and the Ag 3d peaks appeared at 367.8 eV and 374.0 eV, corresponding to Au/Ag alloy-type.<sup>[1]</sup>

[1] R. J. Chimentao, I. Kirm, F. Medina, X. Rodriguez, Y. Cesteros, P. Salagre, J. E. Sueiras, J. L. G. Fierro, *Appl. Surf. Sci.* **2005**, 252, 793.



**Fig. S5** a) UV-vis absorbance spectra of Au/Ag alloy NP-PEC with various molar ratios of Au and Ag, b) plots of the wavelength at the maximum absorbance for various mole fractions of Au/Ag alloy NPs.

The alloy NPs of different compositions can also be distinguished or characterised by their SPR peak shift in the UV-vis spectroscopy. Figure S4 shows the UV-vis absorbance spectra of Au/Ag alloy NPs with various molar ratios of Au and Ag. Au(100%)- and Ag(100%)-PECs showed the characteristic peaks at 529 and 416 nm, respectively (Figure S4a).<sup>[1]</sup> The peak shifted from 439 to 509 nm as a function of increasing Au content from 25% to 75%, respectively, which were gradually close to the peak for Au(100%)-PECs. When the Au/Ag molar ratios were increased, the SPR peak of them was red-shifted toward that of Au(100%)-PECs in a linear fashion without gradual increase or decrease in the absorbance (Figures S4a and b). This pattern is typical for alloy-type NPs and is not observed in core-shell or non-alloy structures. For non-alloy or core-shell Au/Ag NPs, one peak increases in absorbance as its concentration increases with a concomitant decrease in absorbance in the other peak.<sup>[2]</sup>

[1] C. Wang, H. Yin, R. Chan, S. Peng, S. Dai, S. Sun, *Chem. Mater.* **2009**, *21*, 433.

[2] K. Mallik, M. Mandal, N. Pradhan, T. Pal, *Nano Lett.* **2001**, *1*, 319.

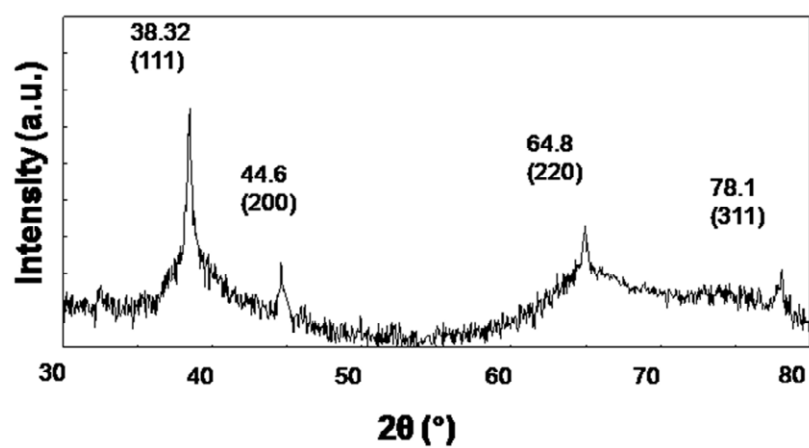
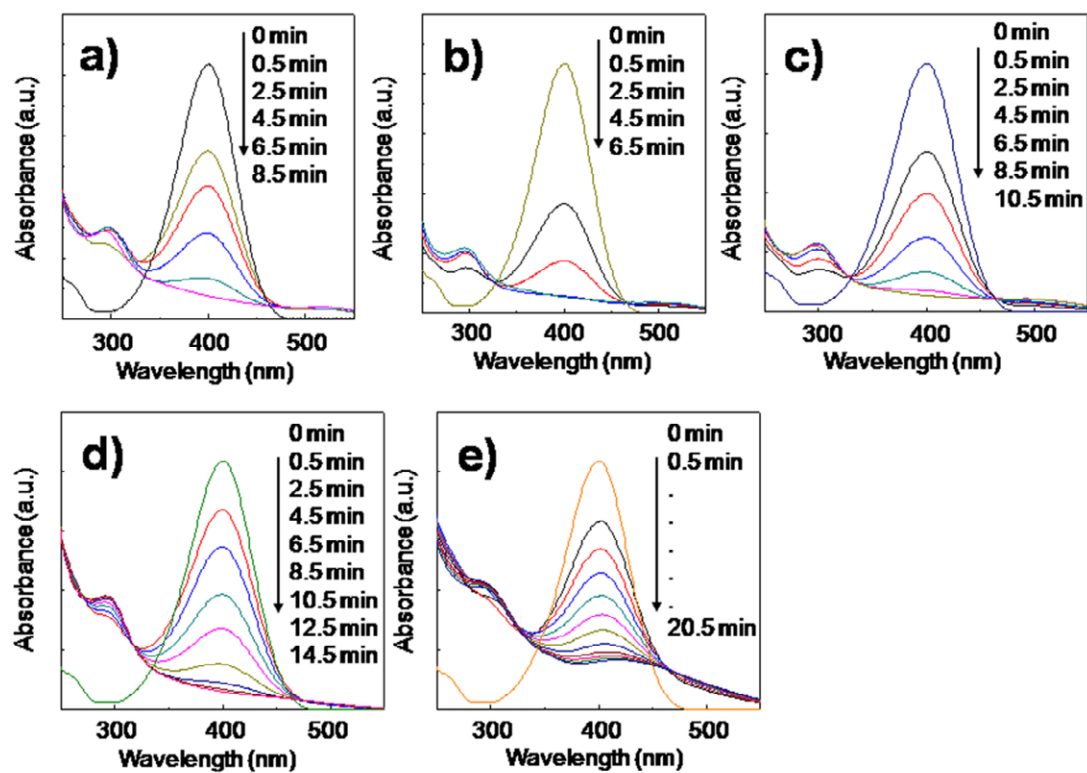


Fig. S6 XRD data of Au/Ag-PECs showing Au/Ag alloy.



**Fig. S7** UV-vis absorbance changes for measuring catalytic performance of a) Au-PEC, b) Au(75%)/Ag(25%)-PEC, c) Au(50%)/Ag(50%)-PEC, d) Au(25%)/Ag(75%)-PEC, and e) Ag-PEC for the reduction of 4-NPh.