Facile Preparation of Carbon-Supported PtNi Hollow Nanoparticles with High Electrochemical Performance

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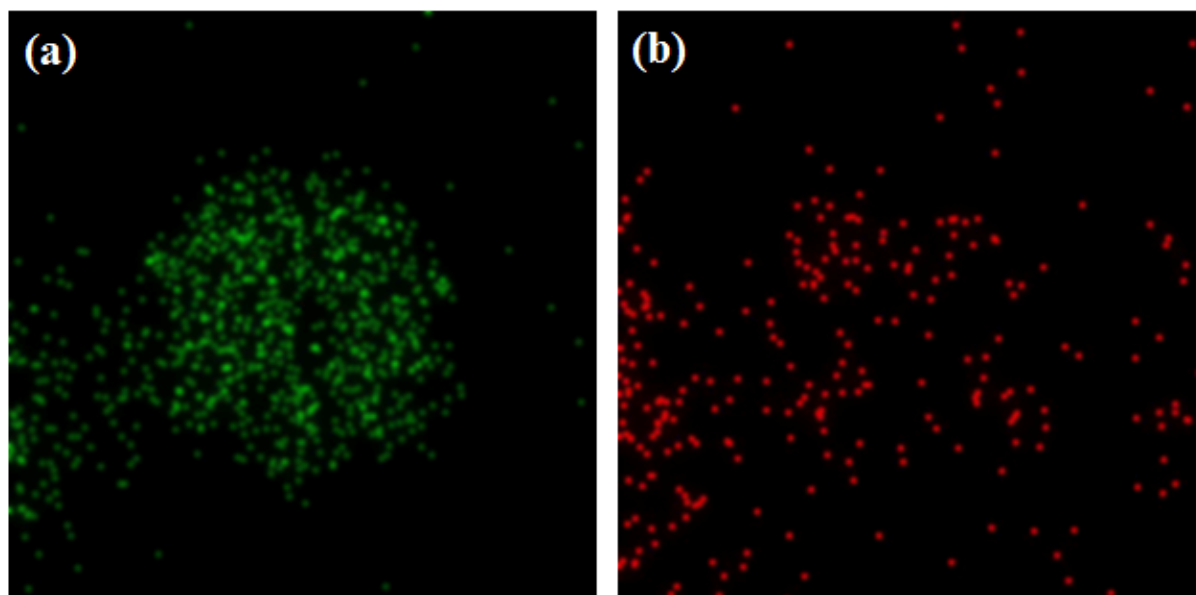E-mail: kimpil1@chonbuk.ac.kr; sookilkim@cau.ac.kr

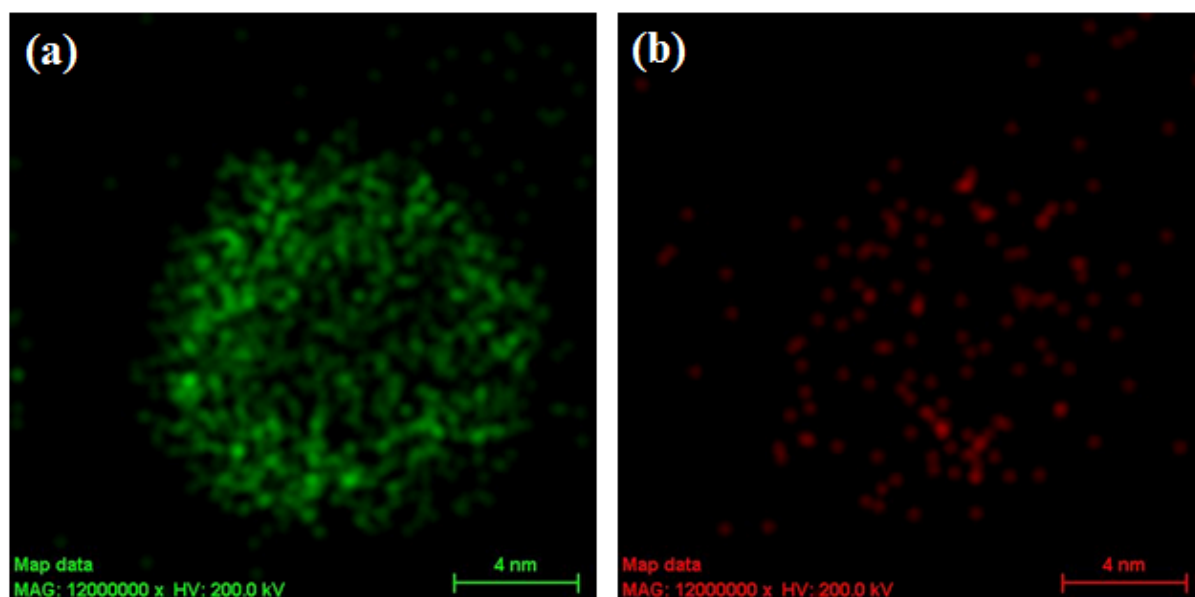**Fig. S1** Elemental mapping of (a) Pt and (b) Ni for PtNi-H/C.

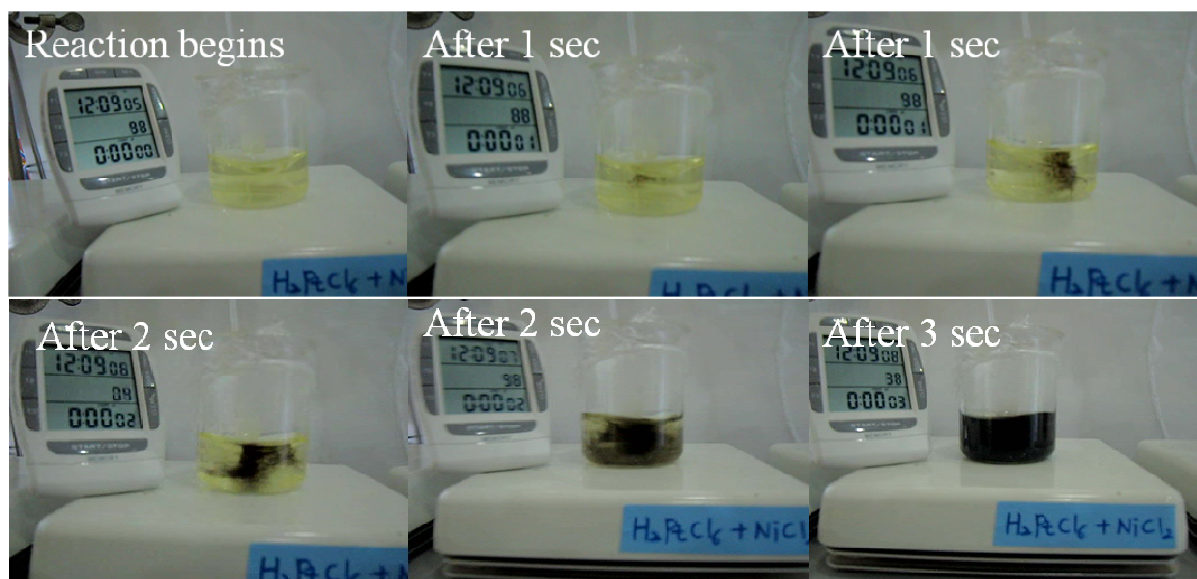**Fig. S2** Elemental mapping of (a) Pt and (b) Ni for PtNi-H-A/C.

Fig. S3 Photographs of precursor solution containing H_2PtCl_6 and $NiCl_2$ during the reduction using $NaBH_4$ solution (320 mM). Each precursor (1.6 mmol) was dissolved in triply distilled water.
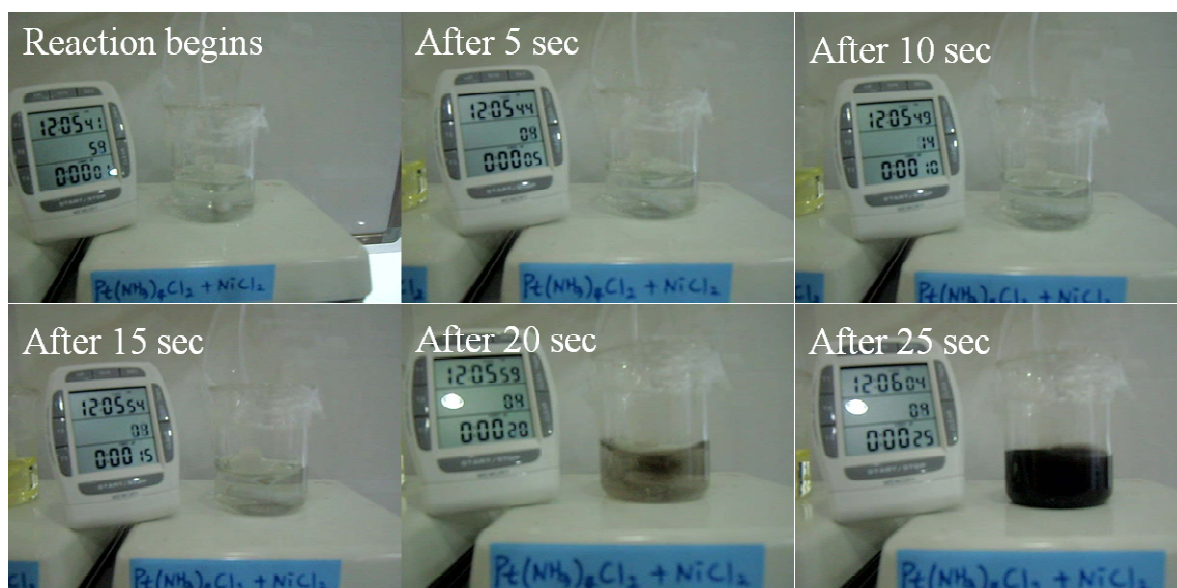
Fig. S4 Photographs of precursor solution containing $Pt(NH_3)_4Cl_2$ and $NiCl_2$ during the reduction using $NaBH_4$ solution (320 mM). Each precursor (1.6 mmol) was dissolved in triply distilled water.
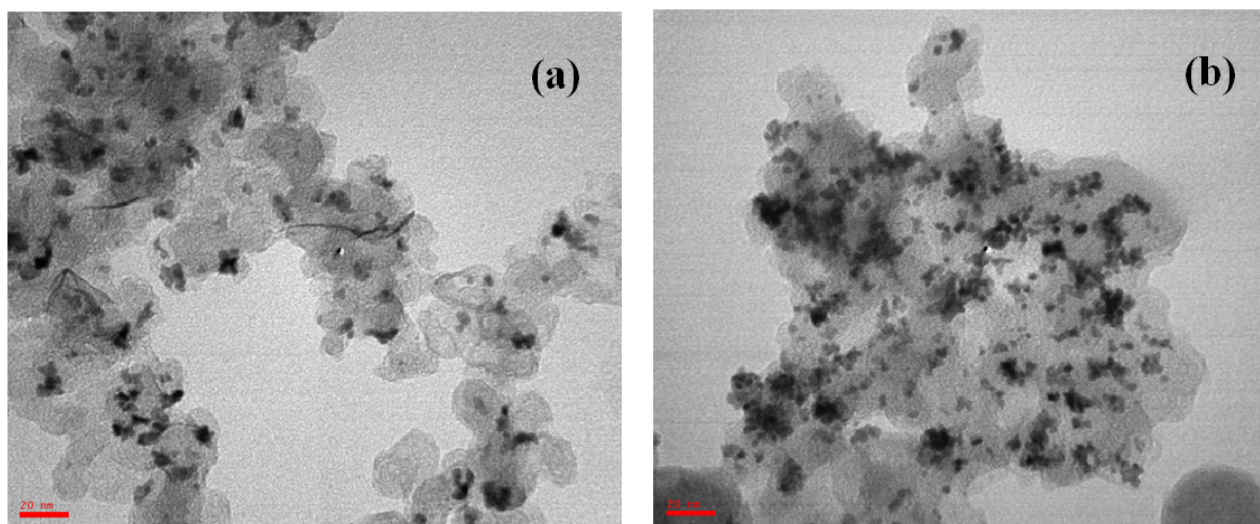
Fig. S5 TEM images of PtNi-S/C and PtNi-S-A/C. The PtNi-S/C and PtNi-S-A/C were prepared using H_2PtCl_6 and $NiCl_2$ precursors through the same procedure as that used for PtNi-H/C and PtNi-H-A/C, respectively. In constrast to PtNi-H/C and PtNi-H-A/C, these catalysts show only solid nanoparticles supported on the carbon support.
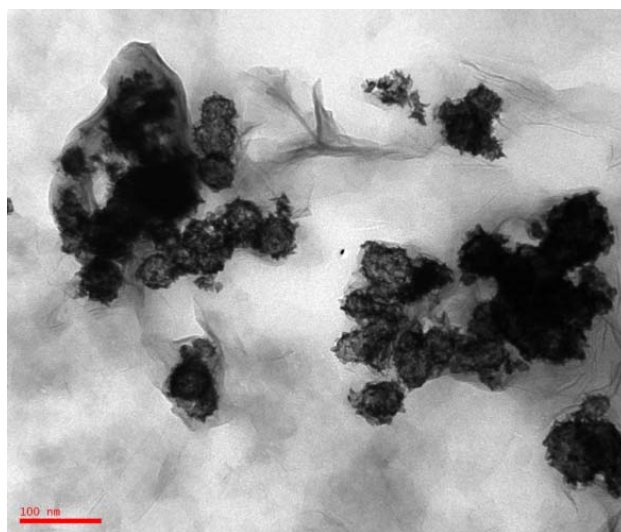
Fig. S6 TEM image of PtNi samples prepared using $Pt(NH_3)_4Cl_2$ and $NiCl_2$ precursor without
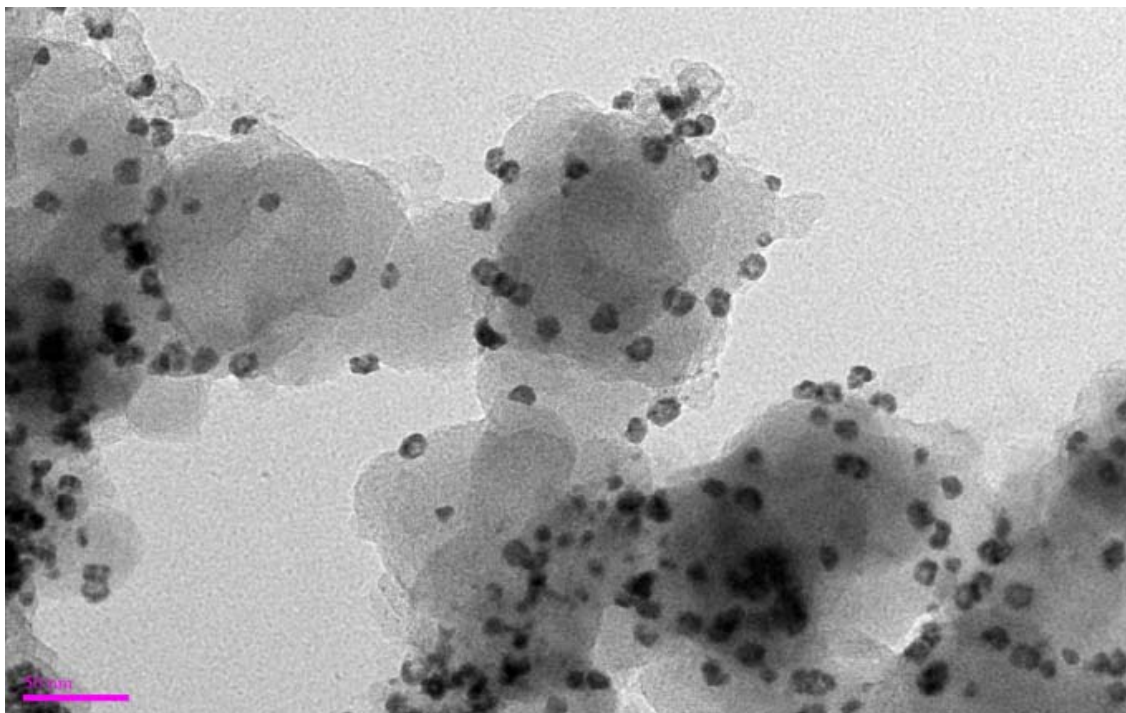
carbon support.

Fig. S7 TEM image of carbon-supported PtNi hollow nanoparticles prepared using Bis(ethylenediammine)platinum (II) chloride and $NiCl_2$ precursors. The atomic ratio of Pt to Ni in the precursor solution was 1.0. The preparation procedure was the same as that in the case of PtNi-H/C.

Fig. S8 TEM image of carbon-supported PtM (M=Co or Cu) hollow nanoparticles prepared using (a) $Pt(NH_3)_4Cl_2$ and $CoCl_2$ and (b) $Pt(NH_3)_4Cl_2$ and $CuCl_2$ precursors. The atomic ratio of Pt to M in the precursor solution was 1.0. The preparation procedure was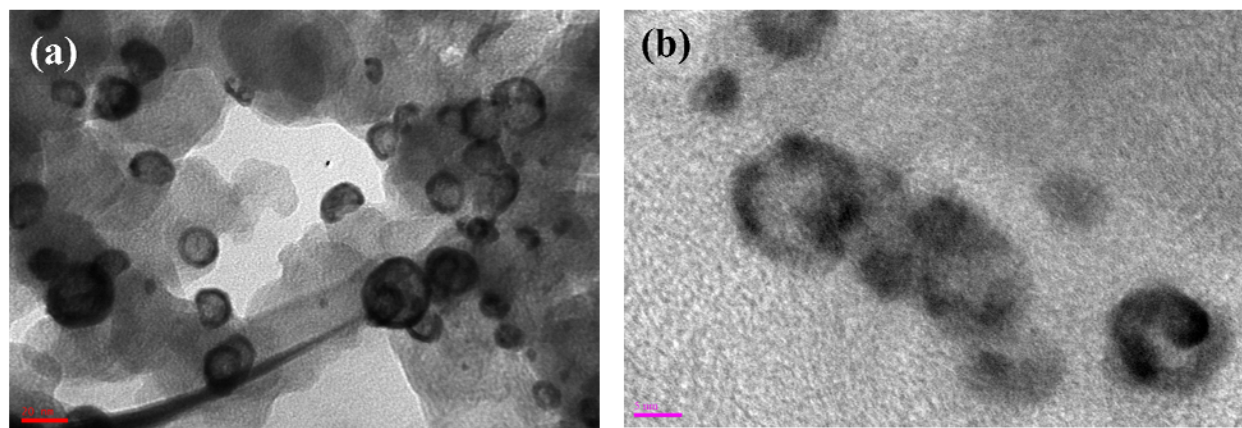 the same as that in the case of PtNi-H/C.