

## Electronic Supplementary Information

### Conversion of bimetallic PtNi<sub>3</sub> nanopolyhedra to ternary PtNiSn nanoframes

by galvanic replacement reaction

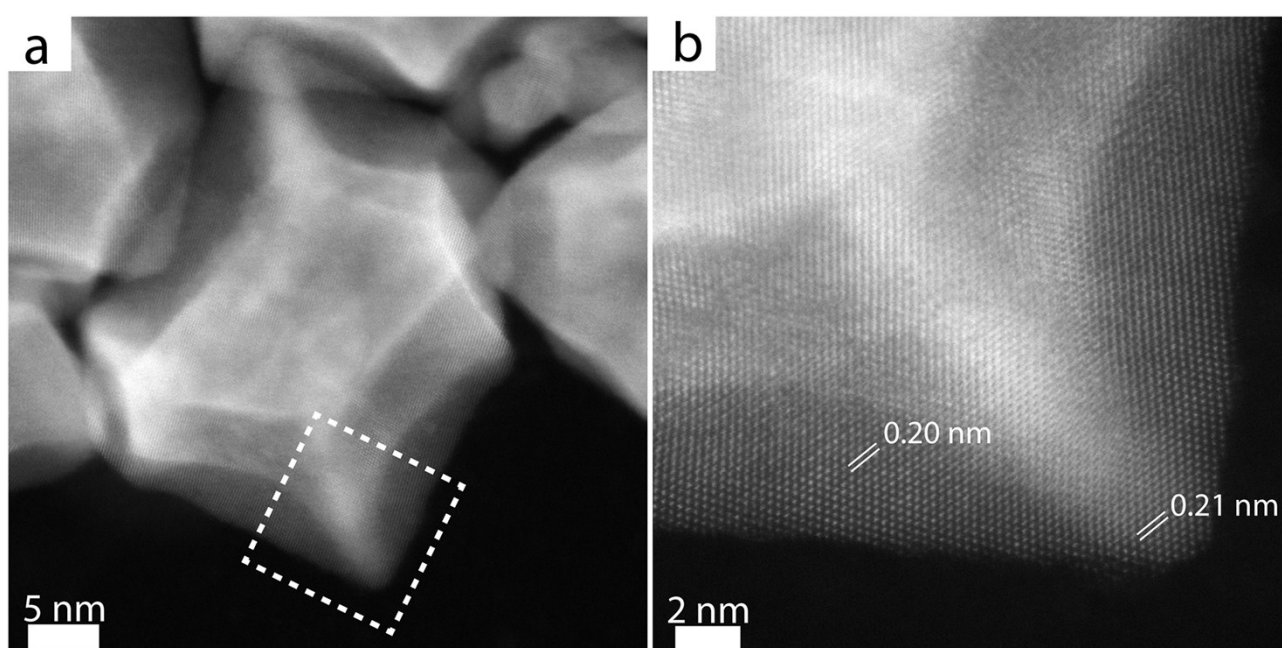
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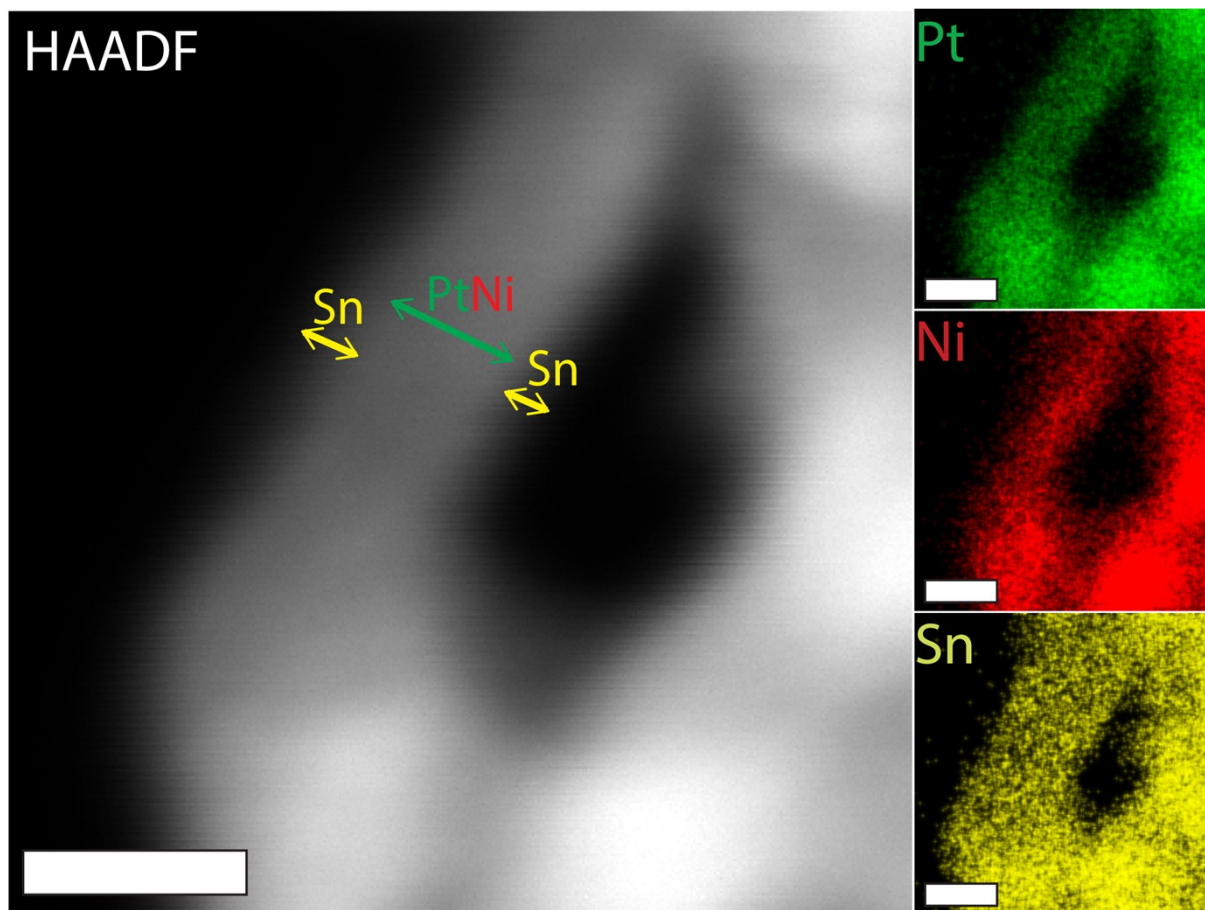
E-mail: gruzel.grzegorz@gmail.com.

<sup>b</sup> Polish Center for Technology Development, PORT Sp. z o.o., 54-66 Wrocław, Poland.

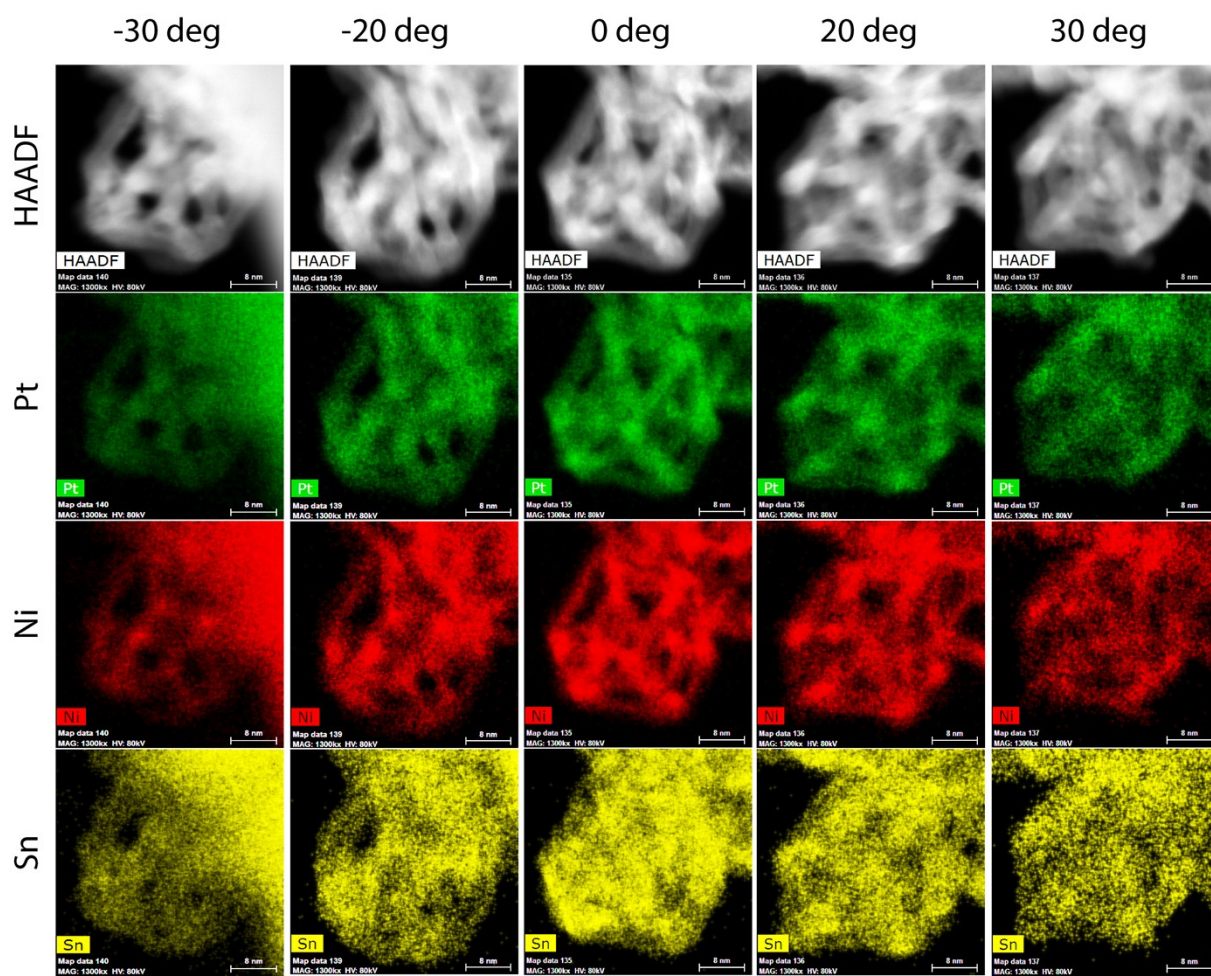
<sup>c</sup> Institute of Engineering Materials and Biomaterials, Silesian University of Technology, Gliwice 44-100, Poland.



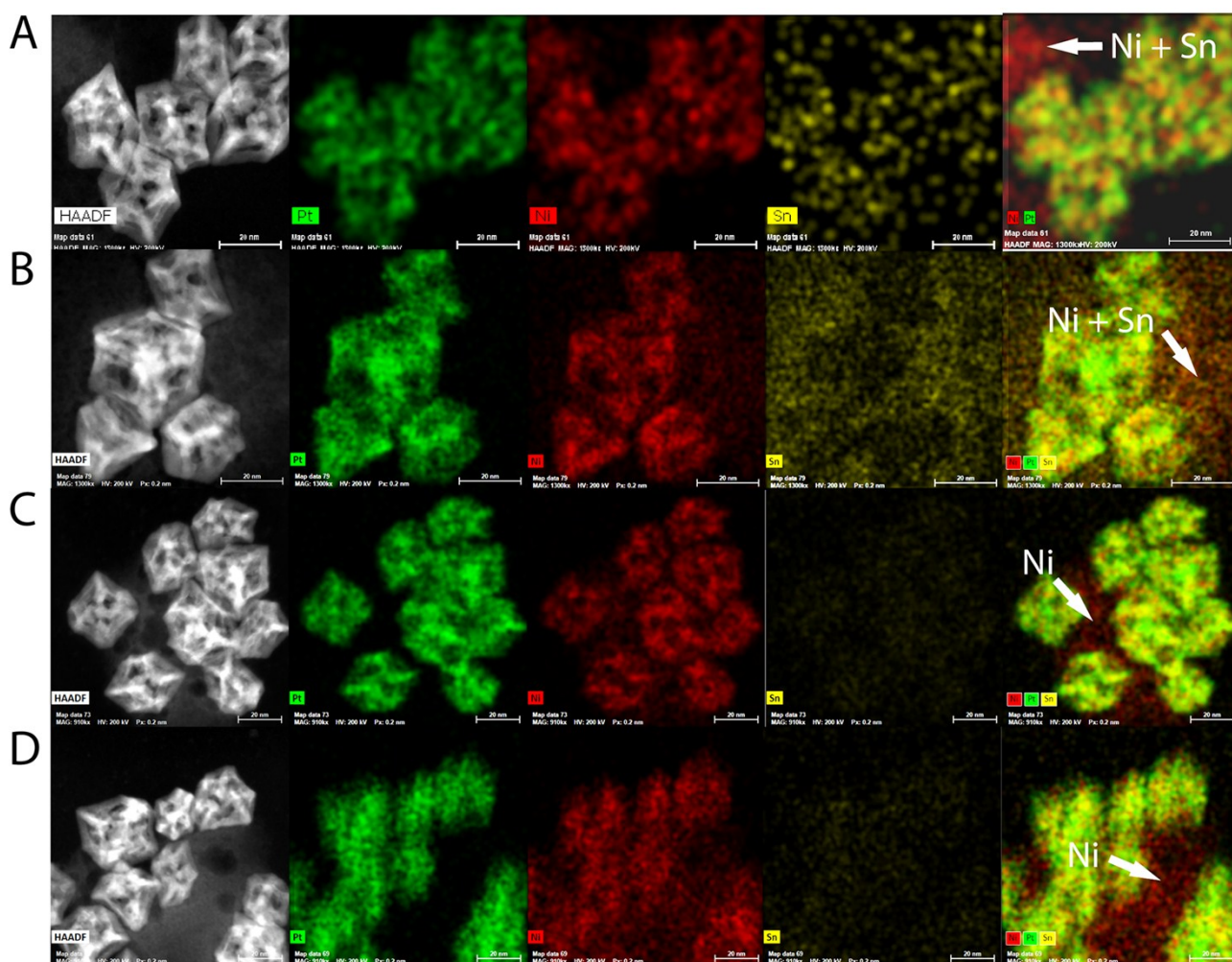
**Figure S 1.** a) High-resolution HAADF STEM image of the PtNi<sub>3</sub> nanopolyhedra; b) magnified area marked in a) with the measured lattice distances on the edge of nanoparticle and on the facet.



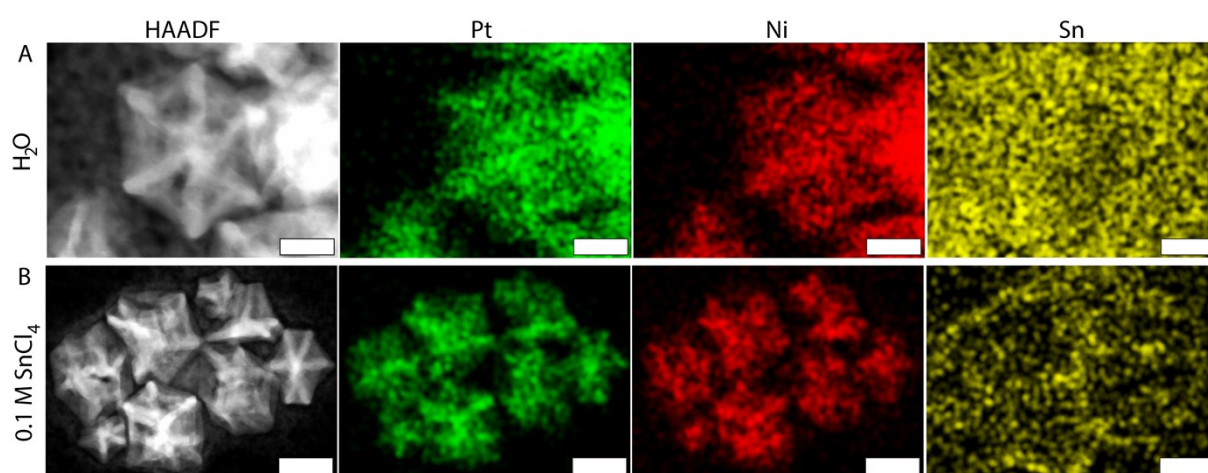
**Figure S 2.** HAADF STEM image and corresponding Pt, Ni, and Sn EDS maps of an edge of a PtNiSn nanoframe. The scale bars are equal to 4 nm.



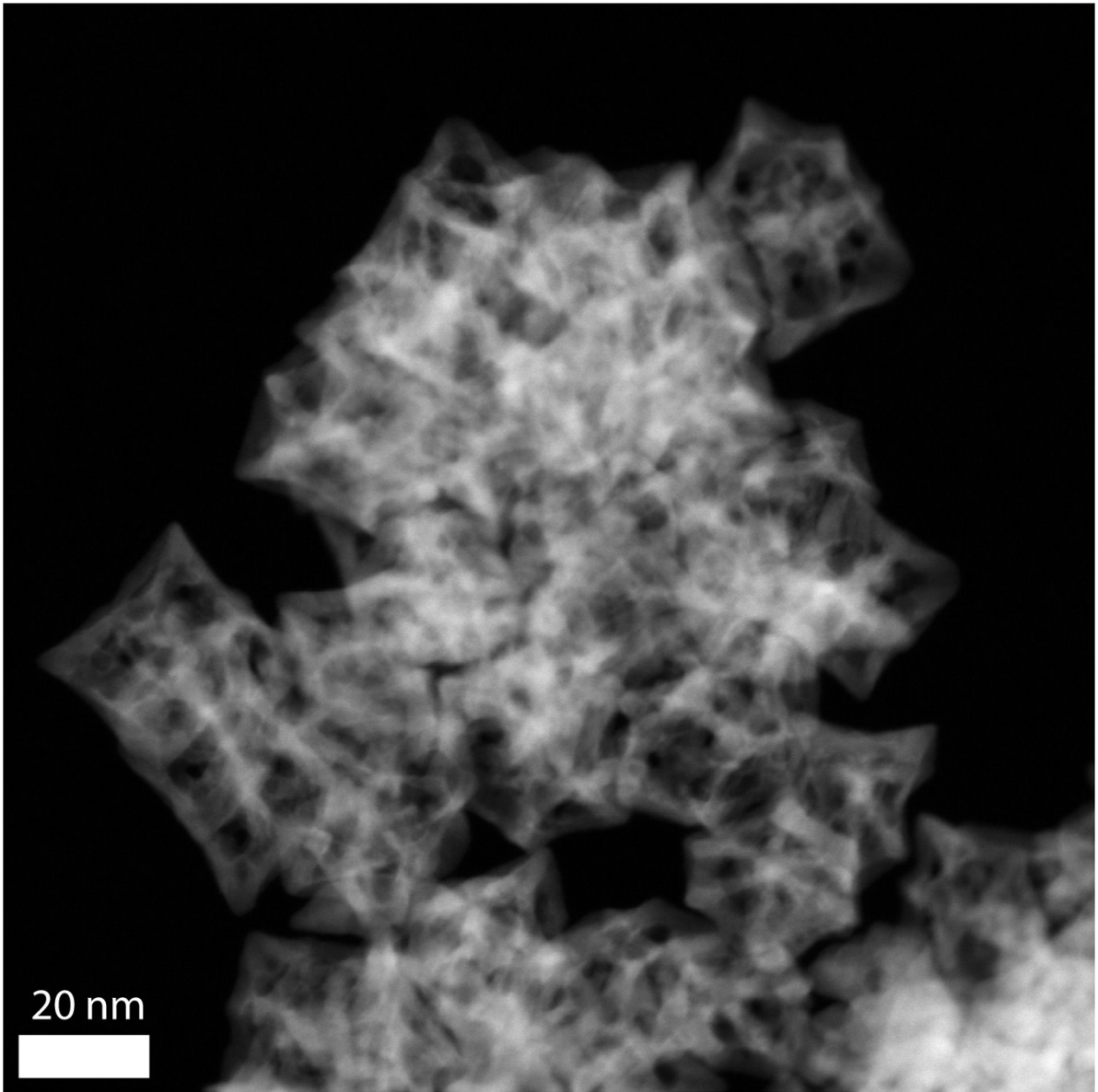
**Figure S 3.** EDS tilt series of PtNiSn nanoframes after 10 h of galvanic replacement reaction. The scale bars correspond to 8 nm.



**Figure S 4.** STEM HAADF images with the corresponding EDS maps showing (A, B) simultaneous diffusion of nickel atoms out of the nanoparticles and tin deposition on the nanoparticles and (C, D) diffusion of nickel from out of the nanoparticles without tin deposition

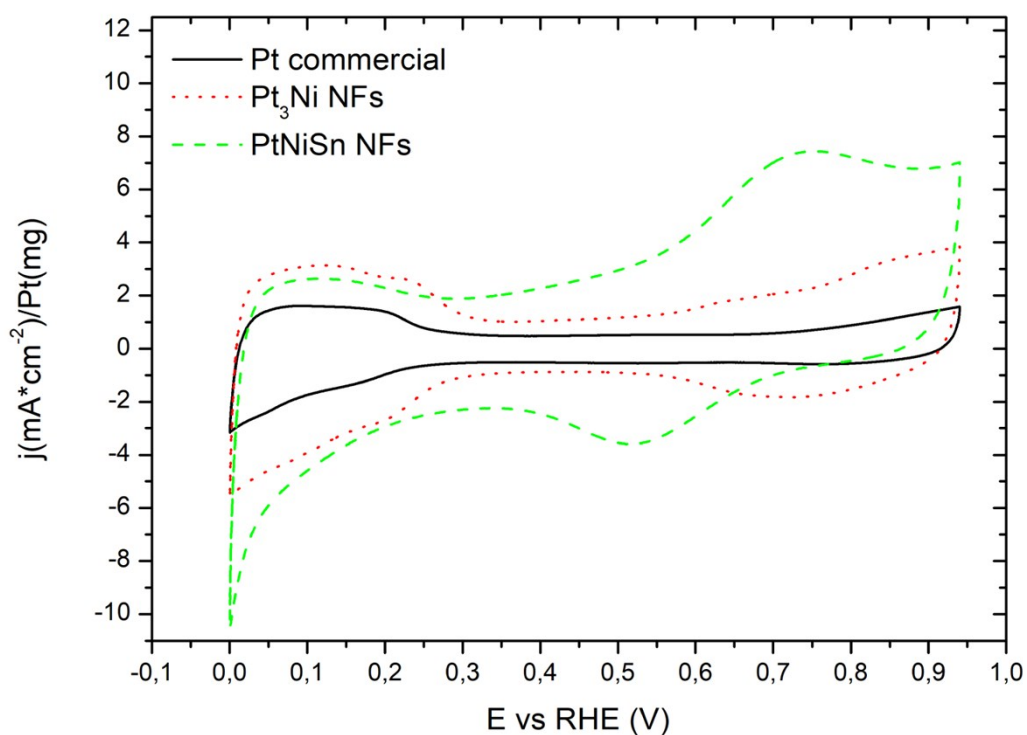


**Figure S 5.** EDS maps of PtNiSn nanoframes after galvanic replacement performed in water (upper row) and in EG with lower concentration of  $\text{SnCl}_4$  (0.1 M vs 1.0 M before; bottom row). The scale bars correspond to 10 nm in the upper row and to 20 nm in the lower row.

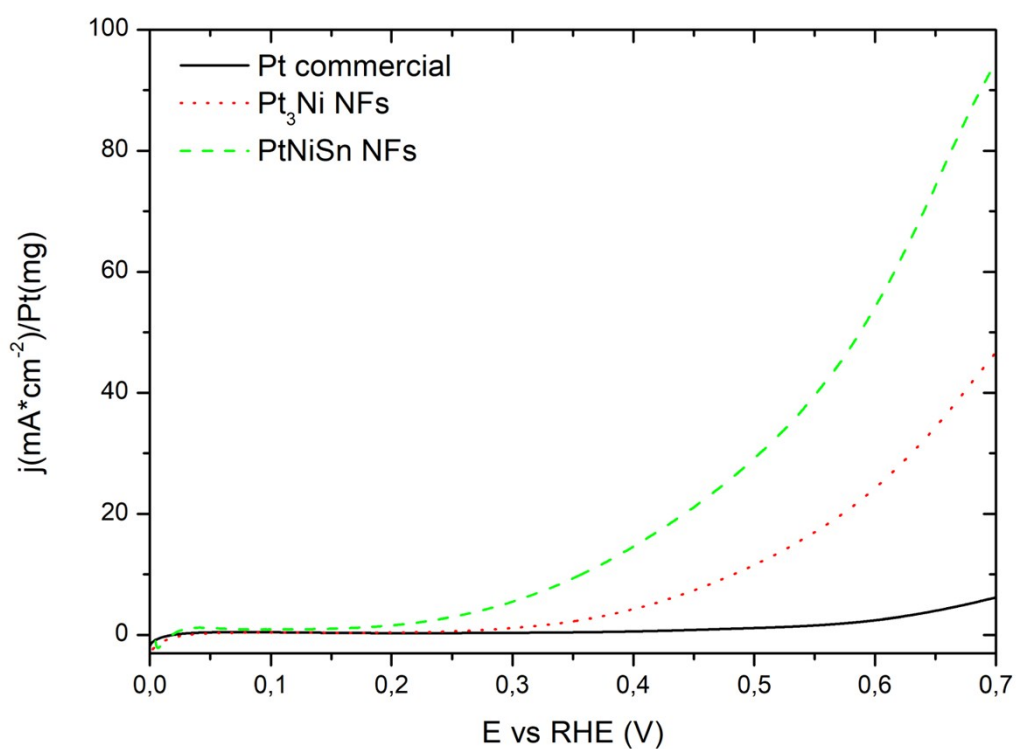


**Figure S 6.** HAADF STEM images of chemically etched Pt<sub>3</sub>Ni nanoframes used as a comparison for electrochemical tests.

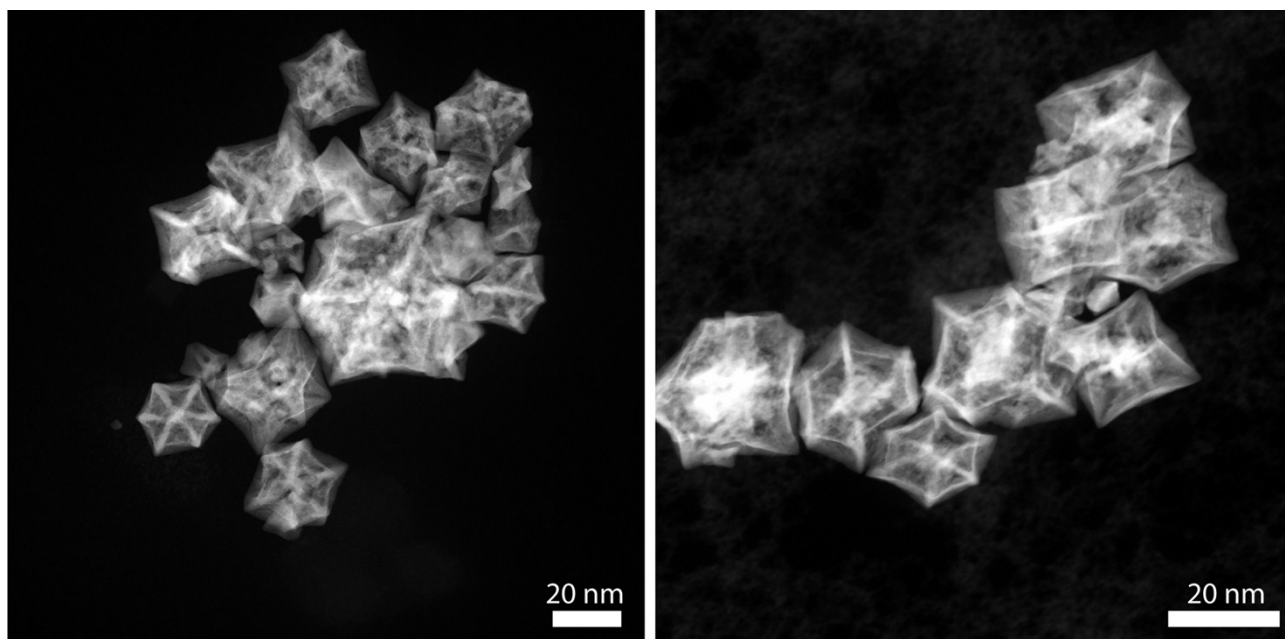
A



B



**Figure S 7.** A) CV profiles of Pt<sub>3</sub>Ni, PtNiSn nanoframes and commercial Pt catalysts recorded in Ar-purged 0.1 M HClO<sub>4</sub> solution, at a scan rate of 20 mV s<sup>-1</sup>. B) first EOR forward scan recorded in 0.1 M HClO<sub>4</sub> + 0.5 M C<sub>2</sub>H<sub>5</sub>OH solution at a scan rate of 10 mV s<sup>-1</sup>.



**Figure S 8.** PtNi<sub>3</sub> solid nanoparticles after ethylene glycol with chloroform treatment for 1 hour.