Supplementary Information for:

Insights into the performance and degradation of Ru@Pt core-shell catalysts for fuel cells by advanced (scanning) transmission electron microscopy

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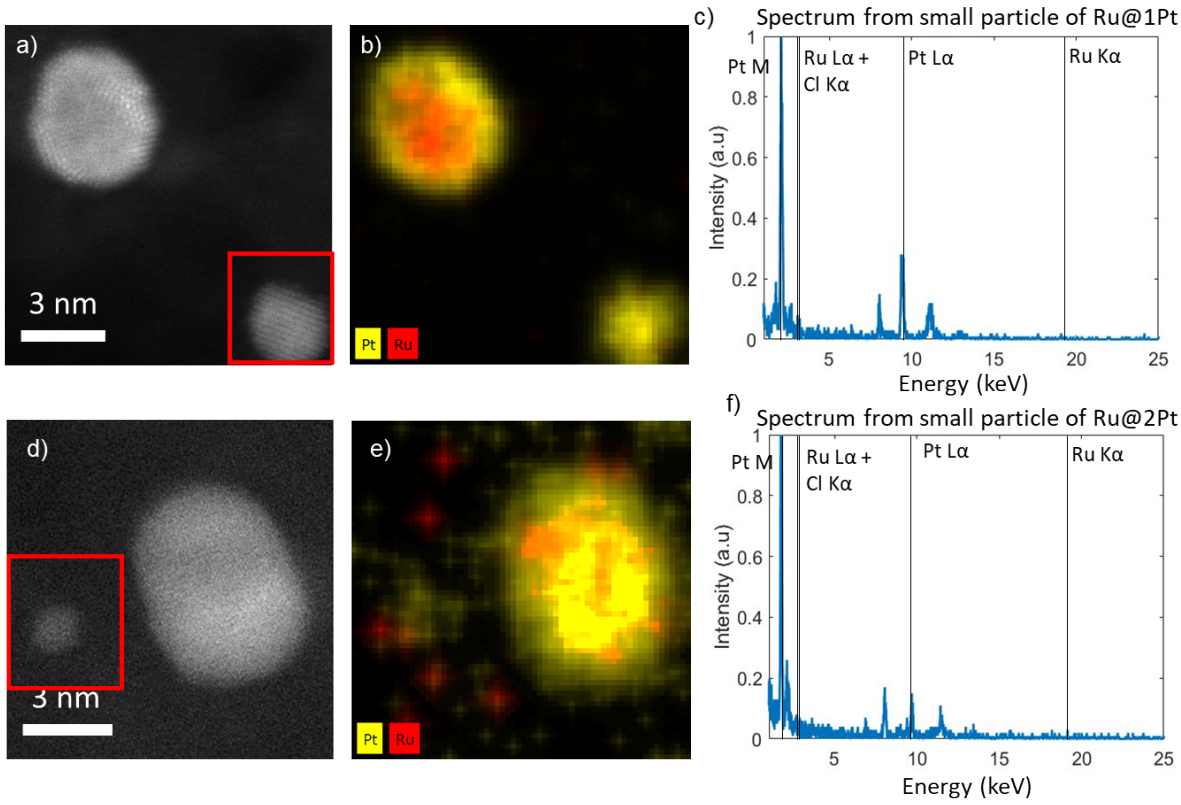
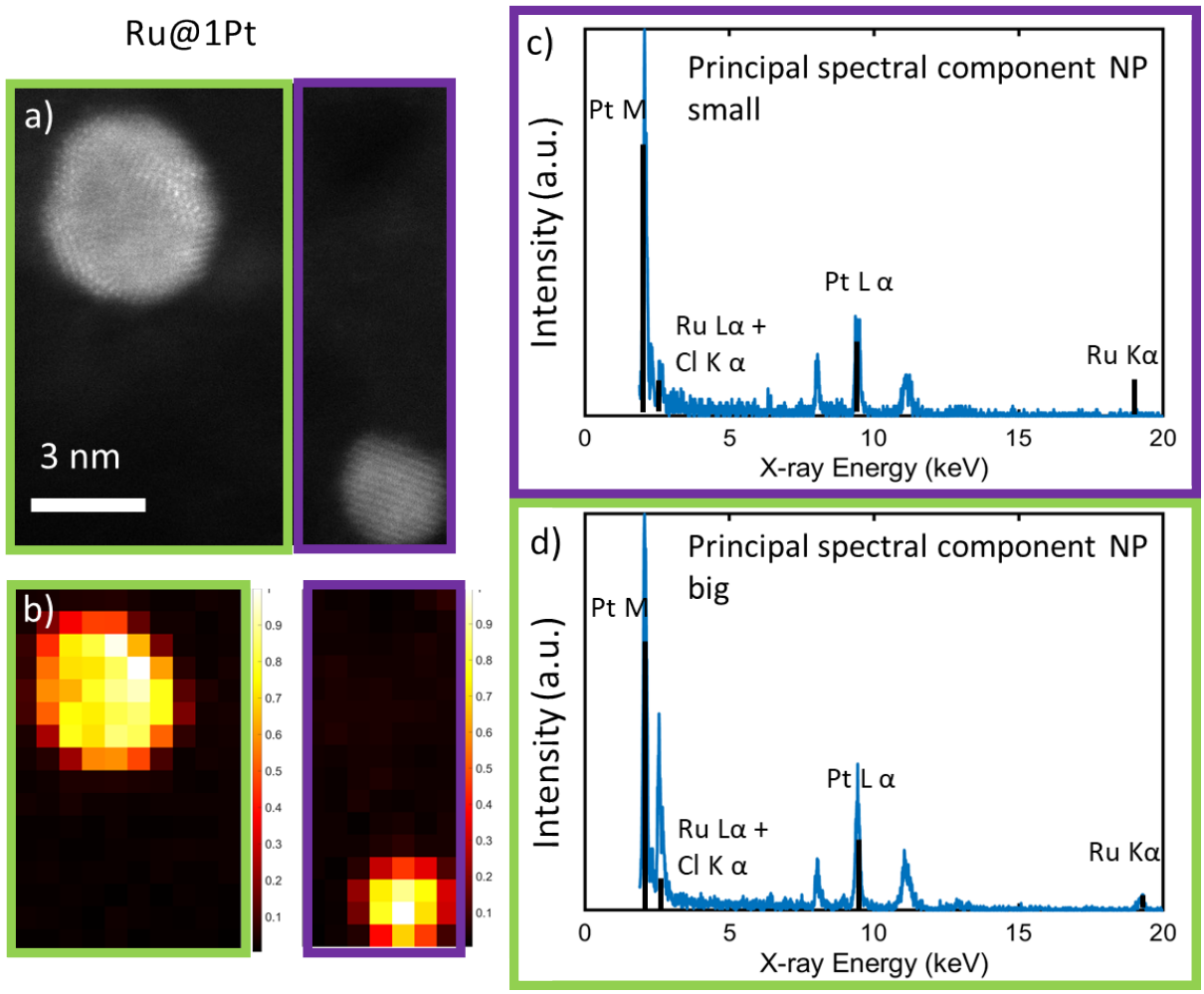
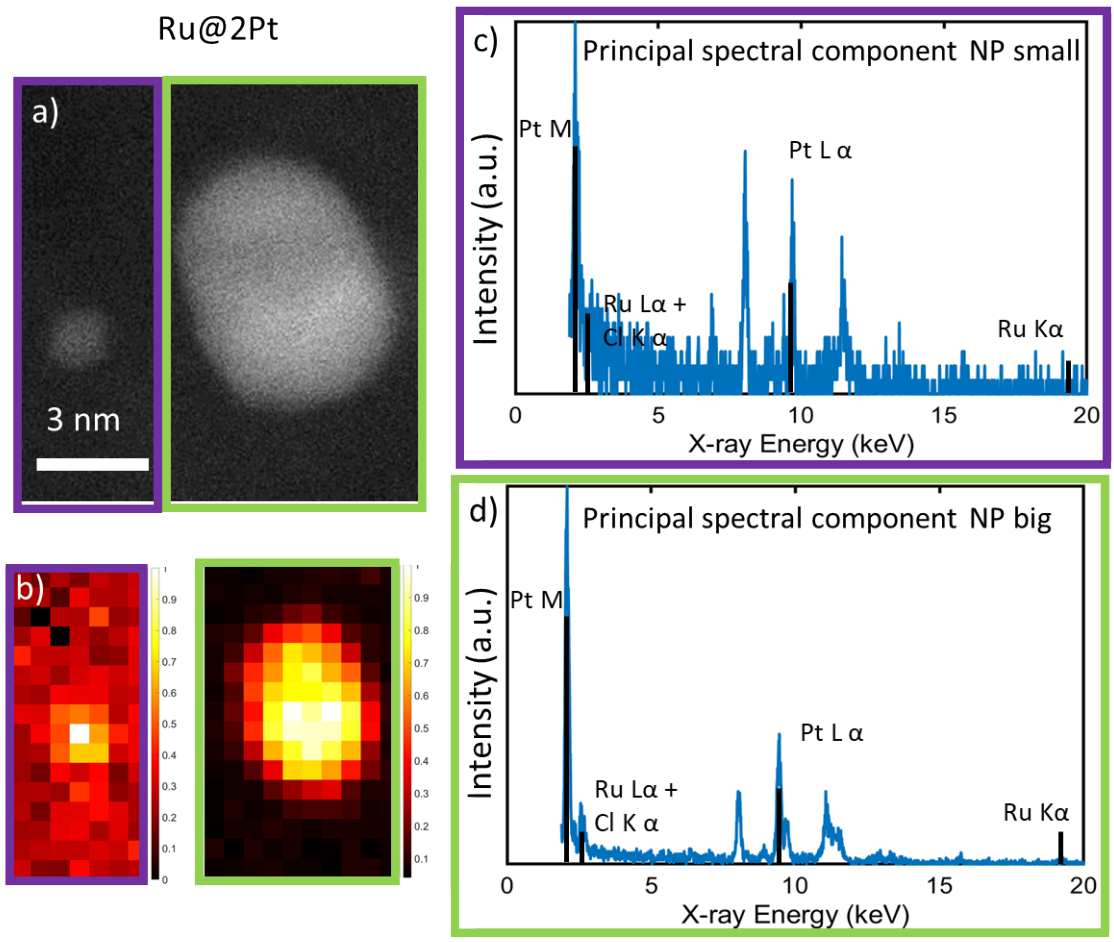


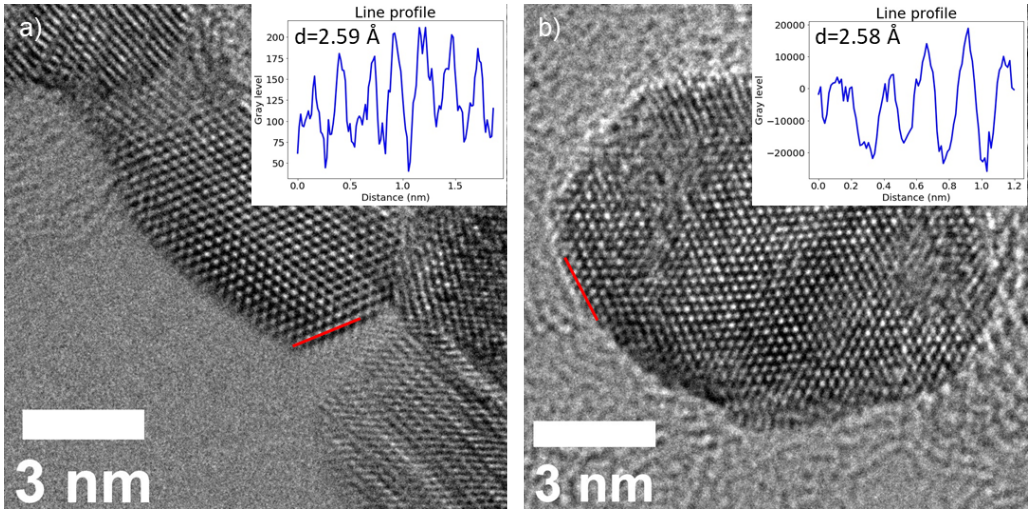
FS1. EDS spectra of the small particles present in Ru@1Pt (a) and Ru@2Pt (f), extracted from the region indicated from a red square in HAADF micrograph (a,d). The corresponding EDS composition maps are also shown in (b,e).In the EDS spectra lines indicating the characteristic X-rays energies of Pt (M=2.048 keV, Lα = 9.44 keV) and Ru (Lα=2.558 keV, Kα =19.23 keV) are shown. Notice how for both samples only Pt signal is detected, and no significant Ru signal is detectable above the background noise.



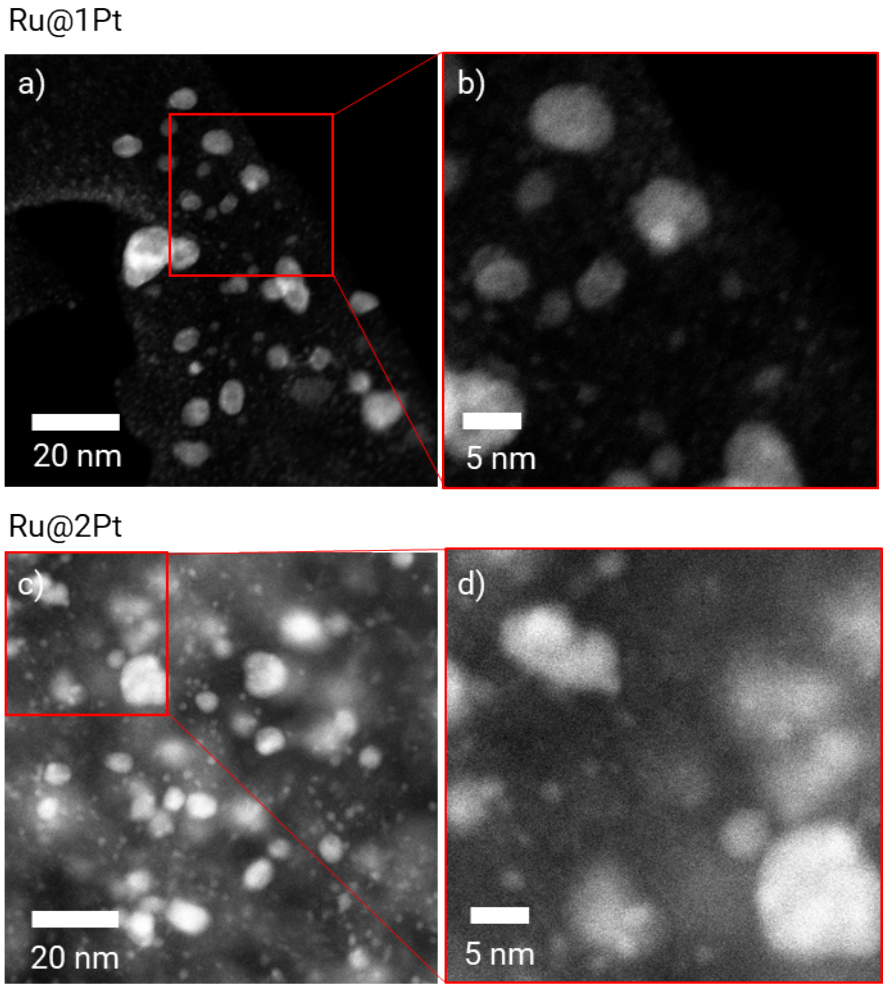
FS2. PCA from the EDS hypermaps of Ru@1Pt. Due to the low EDS signal of the small, pure Pt NP the principal components of each NP had to be extracted separately. a) Corresponding HAADF-STEM micrograph. In b) the weight of the principal spectral components for the small NP (c) and core-shell NP (d) is shown.



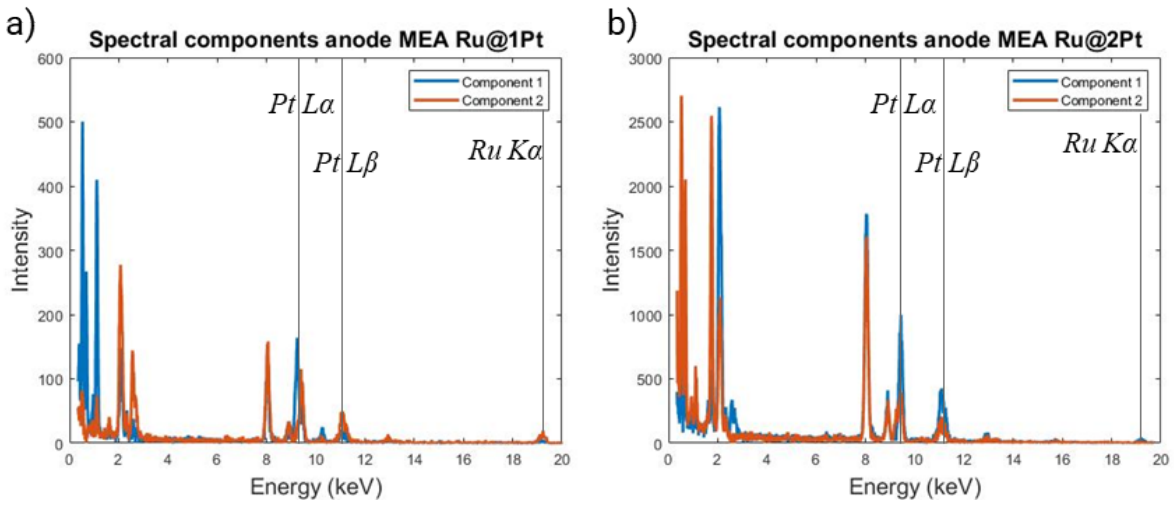
FS3. PCA from the EDS hypermaps of Ru@2Pt. Due to the low EDS signal of the small, pure Pt NP the principal components of each NP had to be extracted separately. a) Corresponding HAADF-STEM micrograph. In b) the weight of the principal spectral components for the small NP (c) and core-shell NP (d) is shown.



FS4. HR-TEM micrographs of Ru@1Pt (a) and Ru@2Pt (b). As insets, the intensity profiles along the shell, showing similar interatomic distances for both samples.



FS5. HAADF-STEM micrographs (a,c) and corresponding digital zoom in (b,d) showing the <1 nm atom clusters present in the anode of the MEAs after cycling.



FS6. Two main spectral components for the anode of the MEA containing Ru@1Pt (a) and Ru@2Pt (b). The vertical lines indicate the characteristic X-rays energies of Pt (Lα = 9.44 keV, Lβ=11.07keV) and Ru Kα (19.23 keV).