Supplementary Information for

Performance evaluation of Pt and Pd mono- and bi-metallic H_2-SCR catalysts for NO emission control applications

Baqer Aljaman,[1] Sarah Komaty,[1] Nawaf M. Alghamdi,[2] Christos Kalamaras,[2] S. Mani Sarathy,[1] and Javier Ruiz-Martinez*[1]

Javier.ruizmartinez@kaust.edu.sa

[1] King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Saudi Arabia

[2] Sustainable Transport Technologies R&D Division, Research & Development Center, Saudi Aramco, Dhahran, Saudi Arabia 31311

Experimental section

H_2-SCR catalytic activity measurements were conducted in a quartz packed-bed reactor with an internal diameter of 10 mm, operated at atmospheric pressure over a temperature range of 150-450 °C. In each experiment, the reactor was loaded with 250 mg of catalyst (35-60 mesh) positioned between two layers of quartz wool. The total flow rate of the reaction feed was maintained at 100 mL/min, corresponding to a gas hourly space velocity (GHSV) of 50,000 h^{-1}. The feed composition consisted of 450 ppm NO, 0.5% H_2, 2.5% O_2, and balance N_2. The H_2-SCR experiments were conducted using a Microactivity Reference system from PID Eng&Tech. The PID system includes an internal thermocouple for temperature monitoring, and Bronkhorst mass flow controllers (MFCs) connected to the PID system for precise control of the reaction conditions. Reactants and products were analyzed using MultiGas™ 2030 FTIR Gas Analyzers (MKS) and TRACE™ 1600 Series Gas Chromatograph (Thermo Fisher Scientific). The FTIR was employed for the analysis of NO, NO_2, N_2O, NH_3, and H_2O, while the GC was used to quantify H_2, N_2, and O_2. Prior to each H_2-SCR measurement, the catalyst was pretreated in a N_2 flow of 200 mL/min for 2 hr at 450 °C, followed by a reduction step of 20 mL/min of 4% H_2/N_2 gas flow for 1hr at 225 °C.

Transmission electron microscopy (TEM) imaging was conducted using FEI Titan Themis Z scanning transmission electron microscope (S/TEM) instrument (FEI Co, Netherlands). The TEM instrument includes an energy dispersive X-ray (EDX) spectrometer. Powdered samples were mounted on copper grids containing a carbon support film.

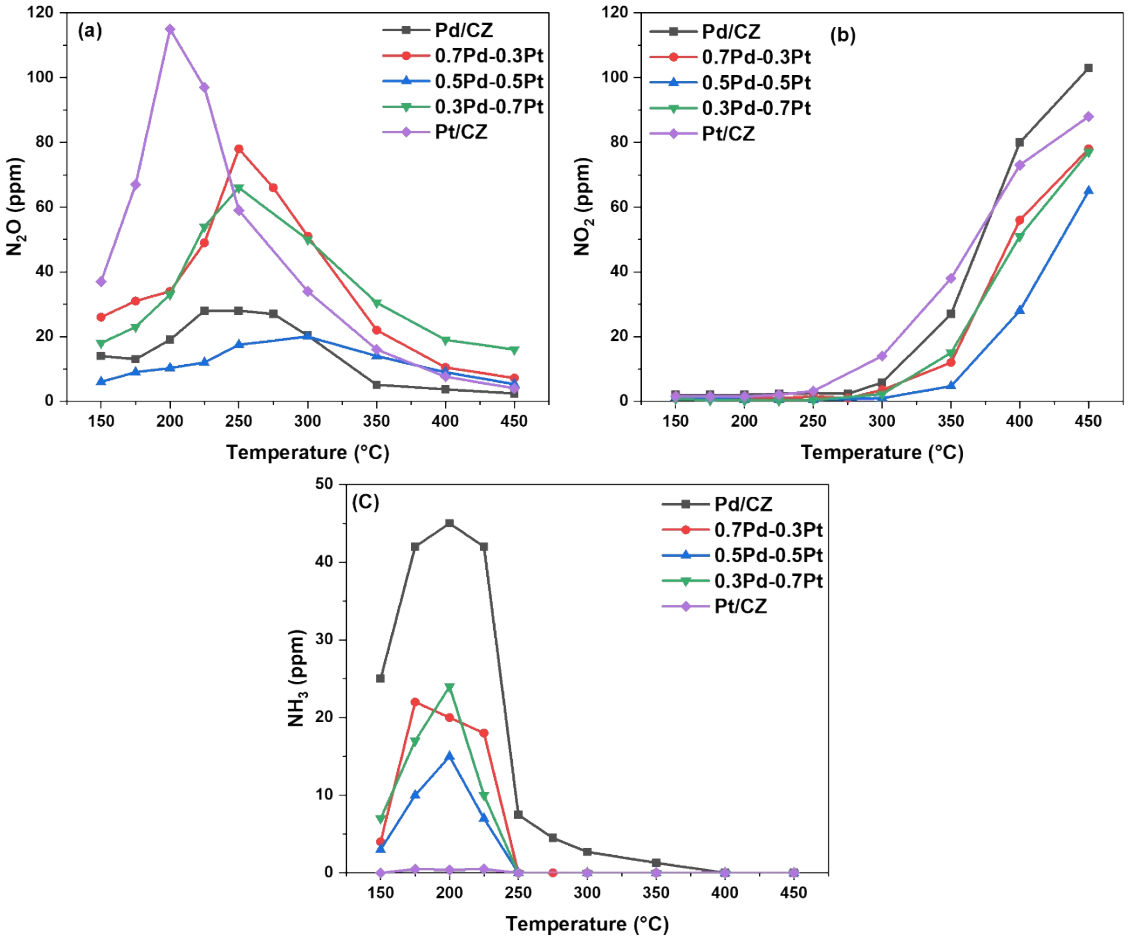

Figure S1: Formation of (a) N_2O, (b) NO_2 and (c) NH_3 over xPd-(1-x)Pt/CZ catalysts (where x=0-1). Reaction conditions: 450 ppm NO, 0.5%H_2, 2.5% O_2, balance N_2, total flow rate=100 mL/min, GHSV=50,000 1/h

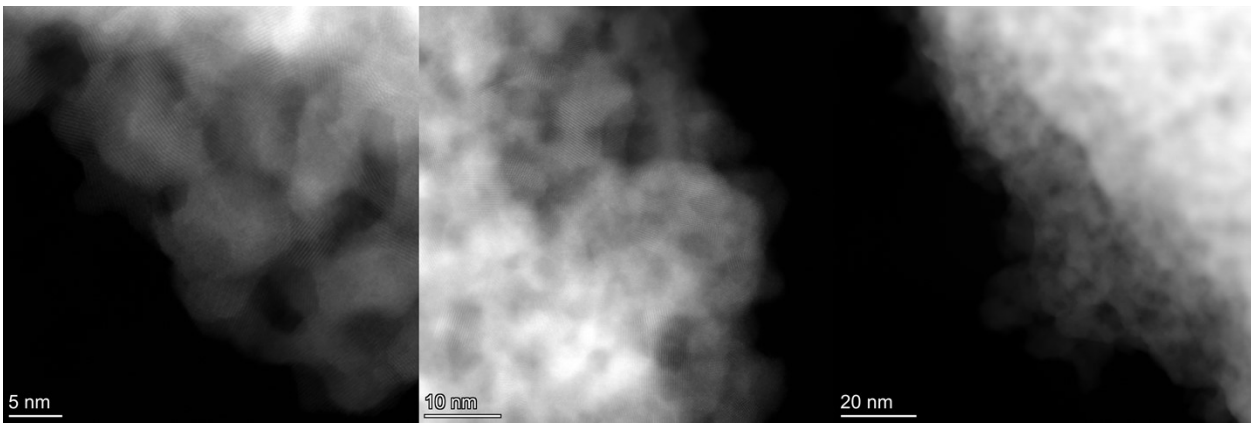

Figure S2: TEM images of Pd/CZ

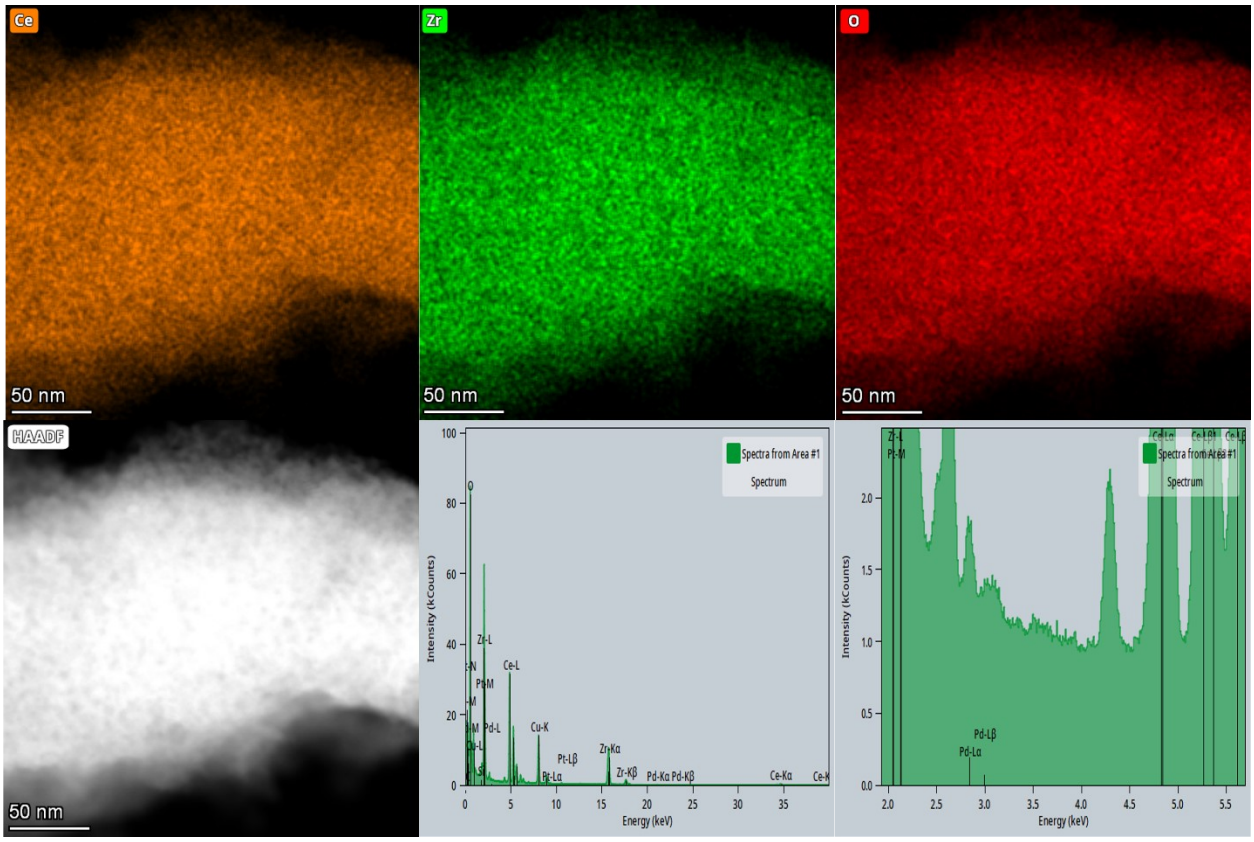

Figure S3: TEM-EDX images and spectra of Pd/CZ

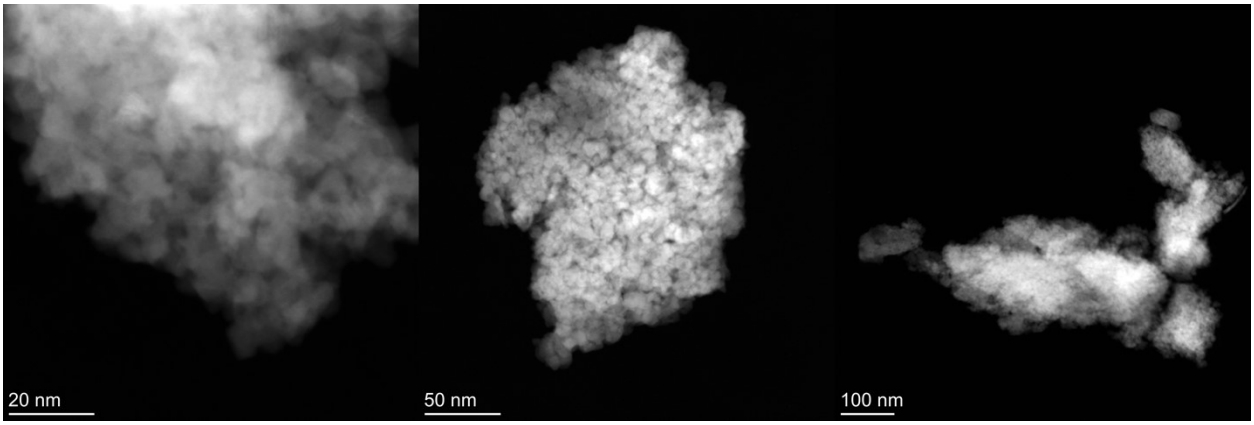

Figure S4: TEM images of 0.7Pd-0.3Pt/CZ

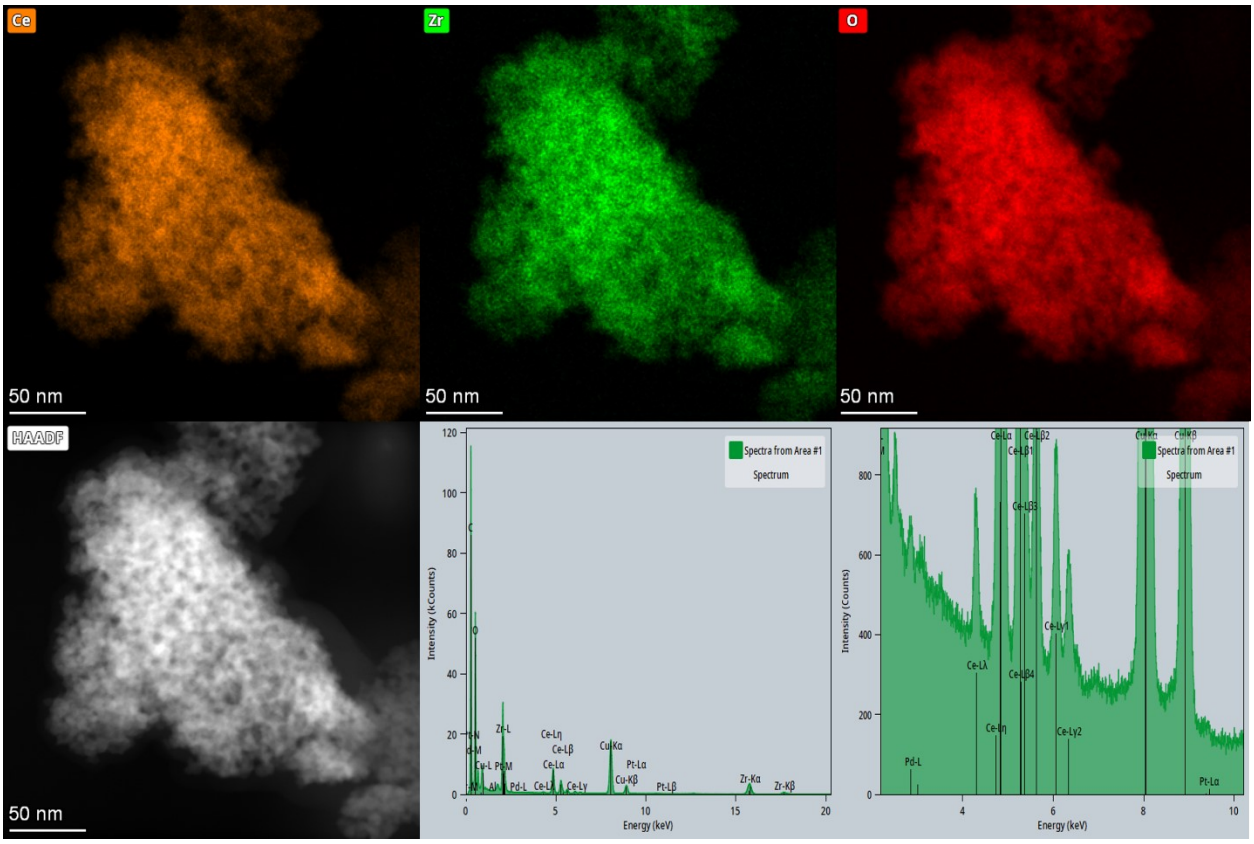

Figure S5: TEM-EDX images and spectra of 0.7Pd-0.3Pt/CZ

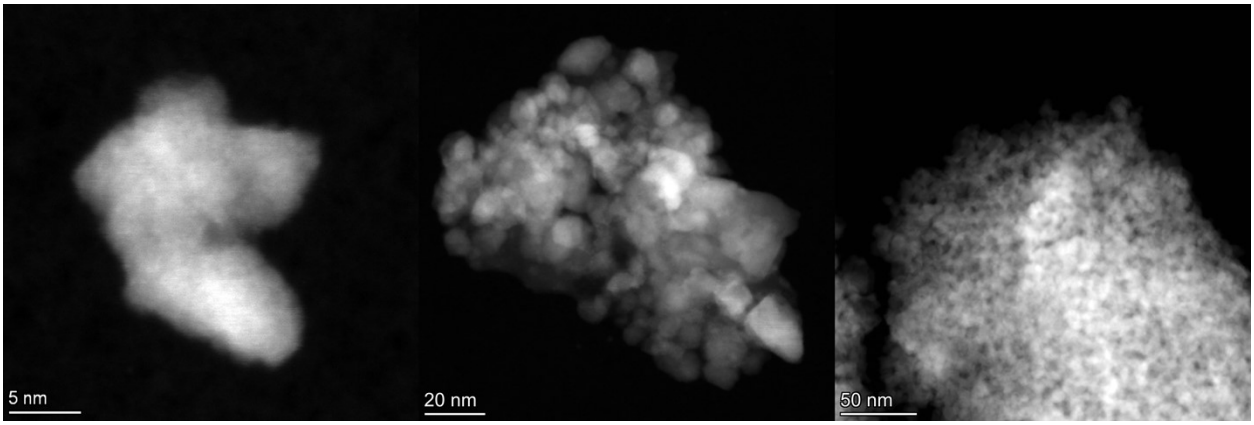

Figure S6: TEM images of 0.5Pd-0.5Pt/CZ

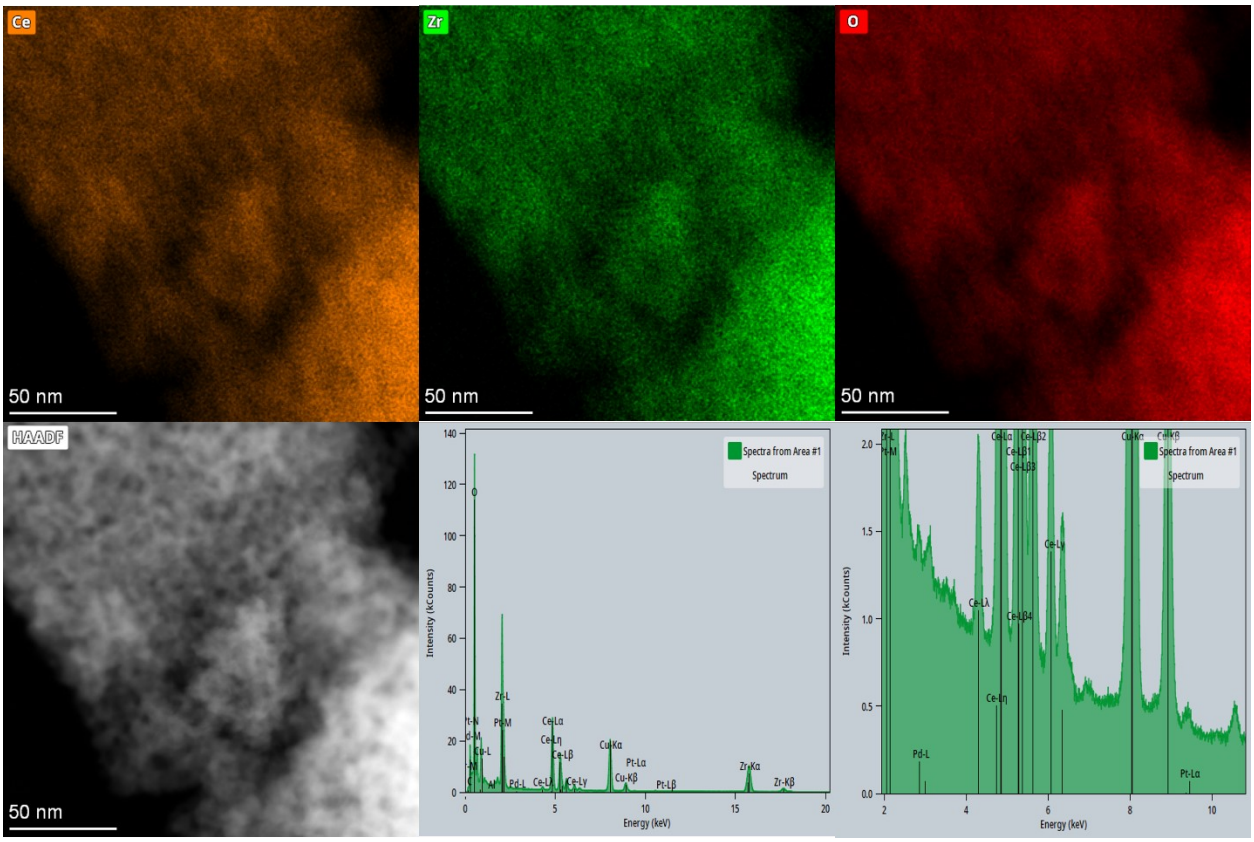

Figure S7: TEM-EDX images and spectra of 0.5Pd-0.5Pt/CZ

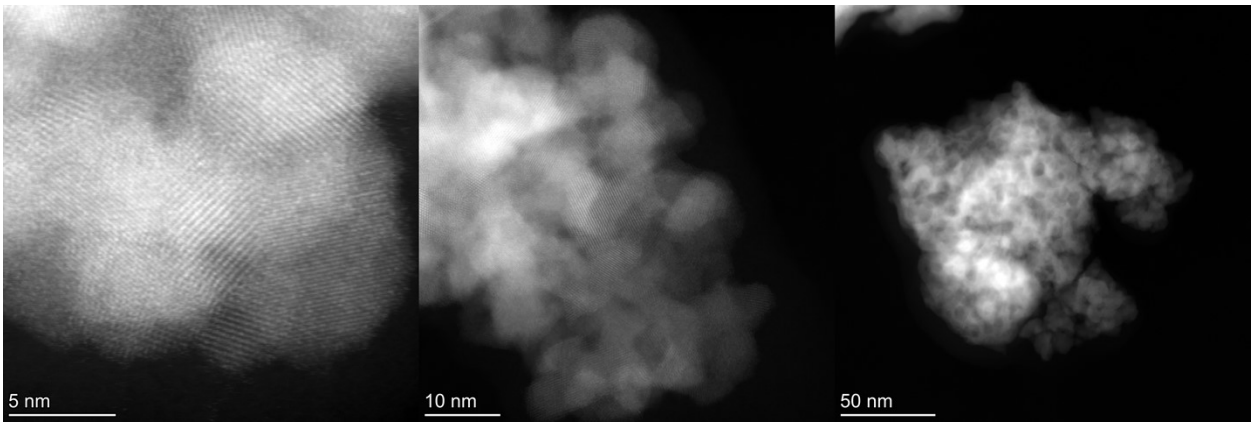

Figure S8: TEM images of 0.3Pd-0.7Pt/CZ

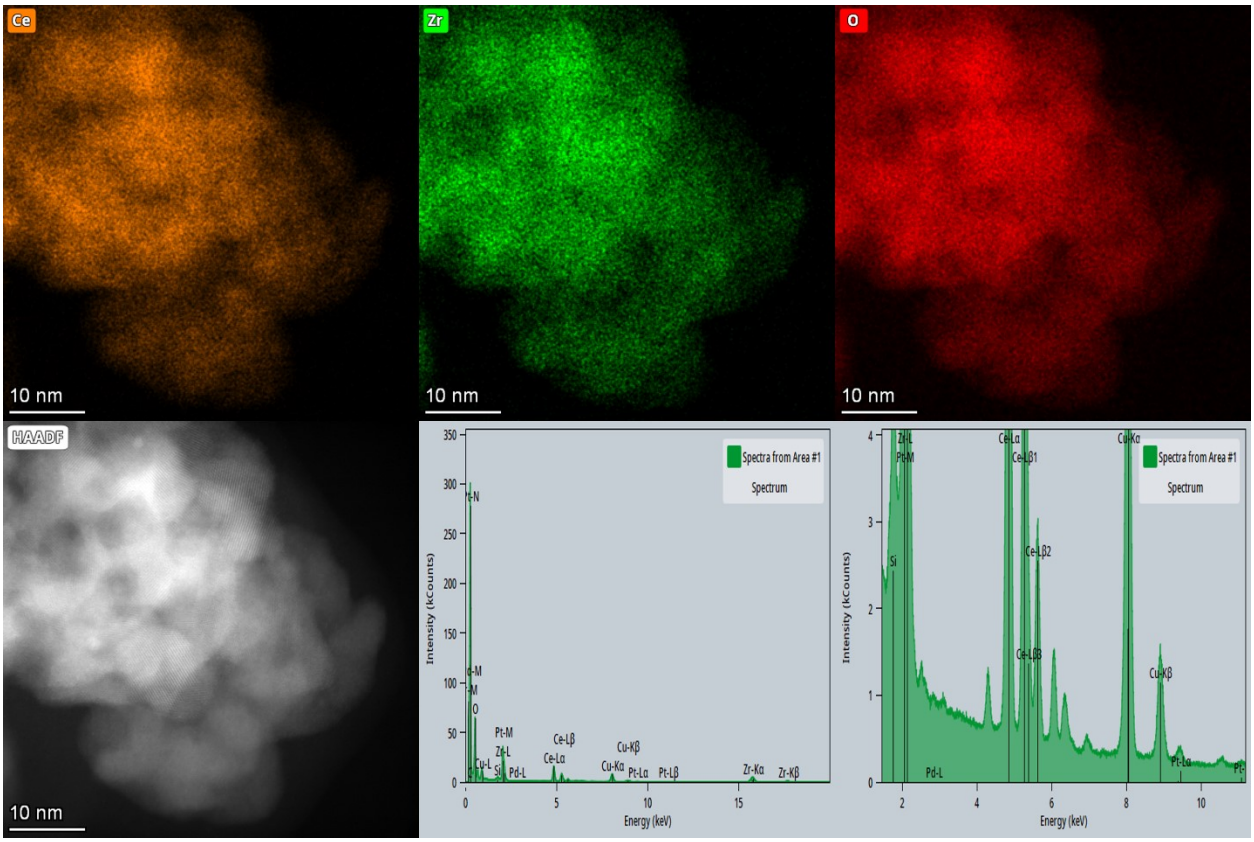

Figure S9: TEM-EDX images and spectra of 0.3Pd-0.7Pt/CZ

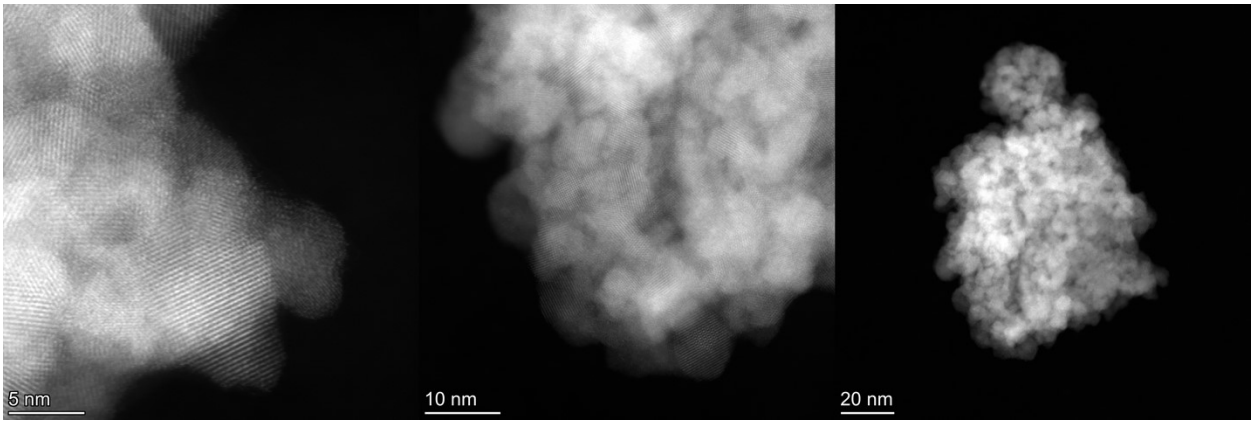

Figure S10: TEM images of Pt/CZ

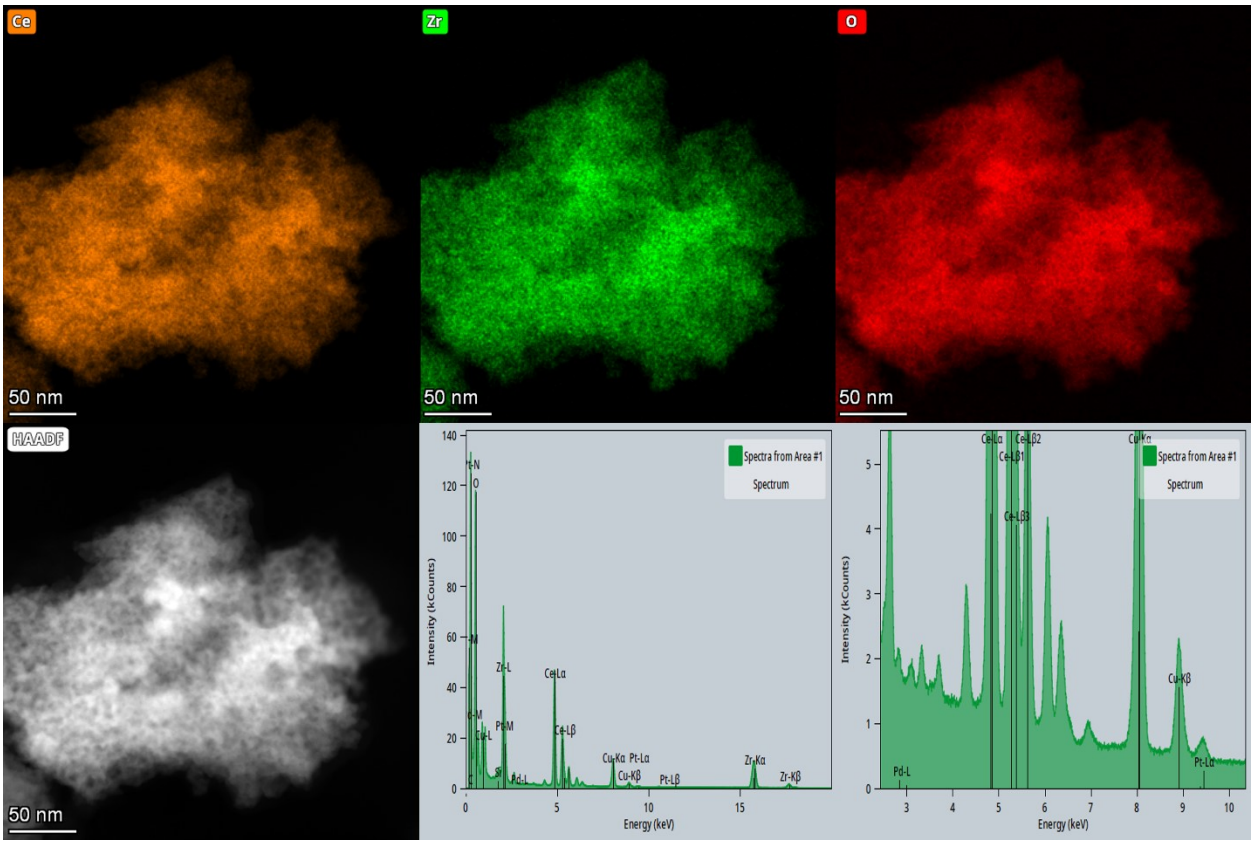

Figure S11: TEM-EDX images and spectra of Pt/CZ