



## Scalable Synthesis of Carbon-Supported Platinum–Lanthanide and Rare-Earth Alloys for Oxygen Reduction

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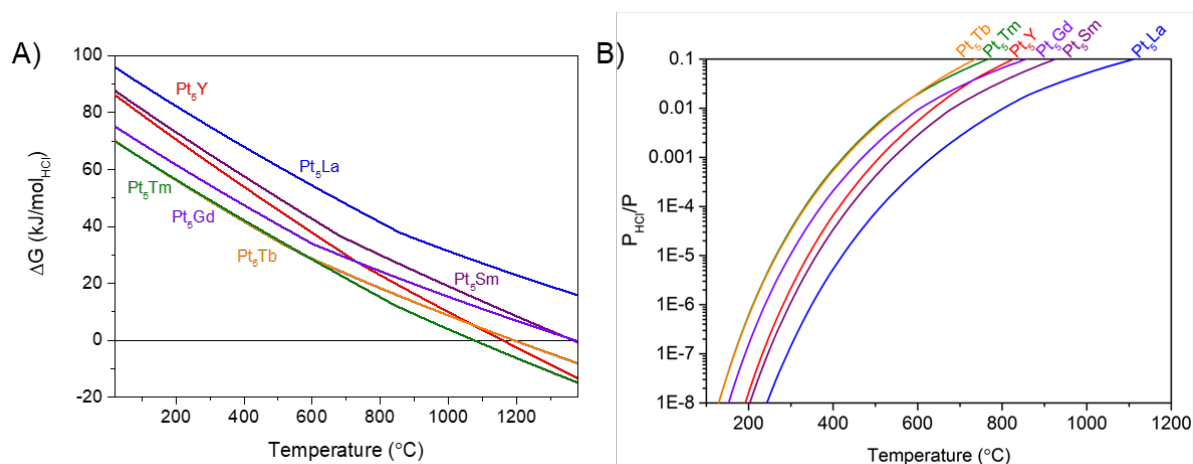
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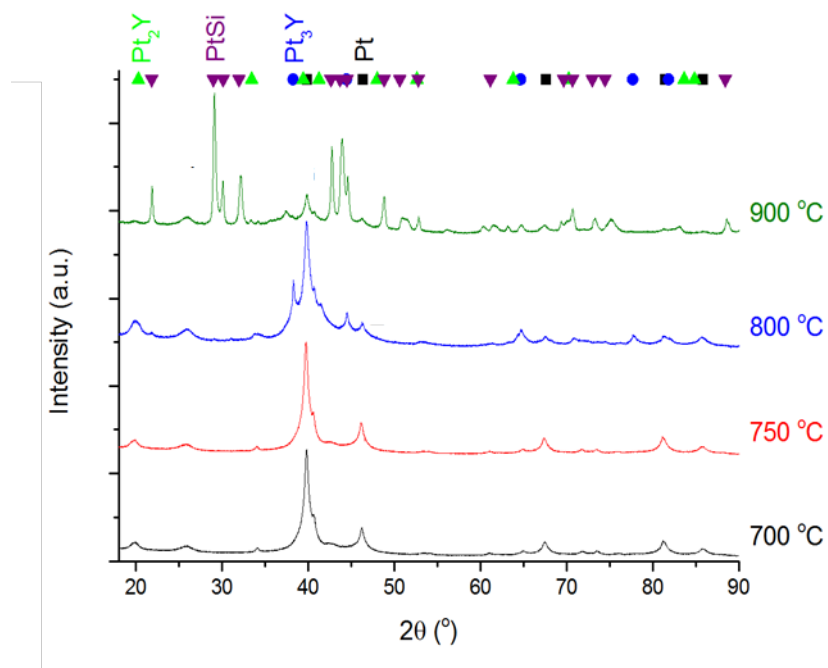
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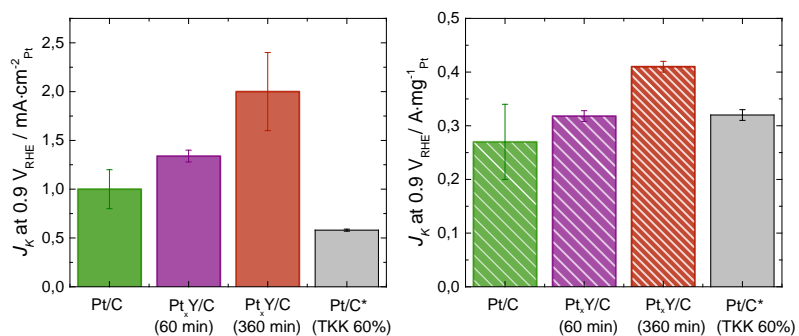
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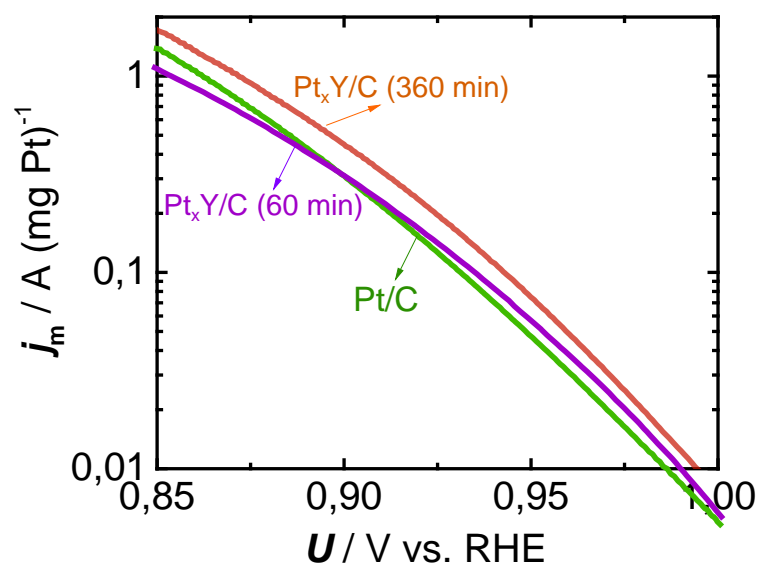
**Figure S1** A) Gibbs free energy in kJ normalised to the moles of HCl produced in the reaction for the thermal reduction of rare earth chlorides, M=Y, La, Sm, Gd, Tb, Tm using hydrogen as a reducing agent over metallic Pt as a function of temperature. B) Approximated equilibrium partial pressure of HCl for the thermal reduction of MCl<sub>3</sub> salts by hydrogen over pure Pt assuming the pressure of H<sub>2</sub> being a constant at 1 bar. For any partial pressure below the equilibrium line for the given alloy entails that the reaction proceeds and that the alloy is formed. For flow systems maintaining partial pressures below the equilibrium is feasible.



**Figure S2** PXRD on samples syntheses from Pt/C and  $YCl_3$  at different temperatures and after acid wash are presented. The synthesis was performed in a quartz reactor under  $H_2$  flow of 10mL/MIN. Reference peak positions for Pt (black square),  $Pt_3Y$  (blue circle),  $Pt_2Y$  (green triangle) and  $PtSi$  (purple diamond) are labelled. Only reference peak positions with relative peak intensity larger than 10% are shown.



**Figure S3.** A) RRDE polarization curves at 1600 rpm and  $50 \text{ mV s}^{-1}$  for the ORR on Pt/C (green curve), Pt<sub>x</sub>Y/C (60 min at  $800^\circ\text{C}$ ) (purple curve), Pt<sub>x</sub>Y/C (360 min at  $800^\circ\text{C}$ ) (red curve) and Pt/C TKK 60% (taken from )nanoparticles catalysts in  $\text{O}_2$ -saturated  $0.1 \text{ M HClO}_4$ . Kinetic current density normalized by (A) specific surface area and (B) mass of Pt at  $0.9 V_{RHE}$  for Pt/C and Pt<sub>x</sub>Y/C annealed for 30 and 360 min at  $800^\circ\text{C}$ , based on data from A).



**Figure S4.** Tafel plots of Pt/C (green), Pt<sub>x</sub>Y (60 min) (purple) and Pt<sub>x</sub>Y (360 min) (red) in O<sub>2</sub>-saturated 0.1 M HClO<sub>4</sub> at 1600 rpm with iR correction.