Synthesis and in-situ Structural X-ray Investigation of Pt alloy nanoparticle catalysts

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We aim to characterize and understand at a molecular level the structural and compositional changes which occur when Pt alloy nanoparticle are catalyzing surface electrocatalytic reactions under controlled potential conditions. In particular, we apply synchrotron-based ex-situ Small Angle X ray Scattering (SAXS) and X ray diffraction (XRD) (Fig. 1) and develop in-situ capabilities for these methods in order to probe the changes in particle size and composition distribution time resolved under reactive conditions.

We have applied our X ray studies to novel highly active Pt-Cu alloy catalysts for the electroreduction of oxygen. SAXS studies established synthesis-structure relationships, such as annealing temperature and initial alloy particle size (Fig.2). Using in situ XRD and electrochemical methods, we have demonstrated that the electrochemical removal of Cu results in the active catalyst phase (Fig. 3). In-situ XRD and SAXS data evidence that the mean particle size of the initial alloy particles drops significantly during the formation of the active catalyst phase.

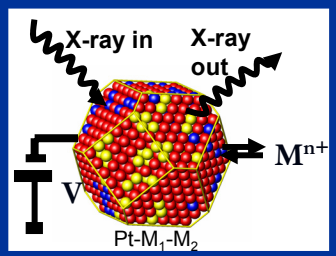

Fig.1 Alloy Nanoparticles Studied by X rays under Potential control

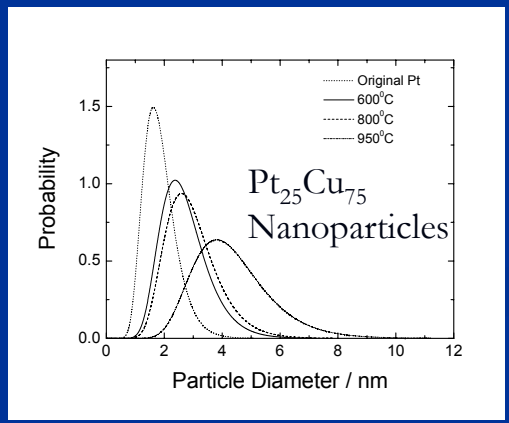

Fig.2 Particle size distributions of Pt-Cu alloys as function of annealing temperature

Fig.3 In situ XRD revealed the gradual loss of Cu from Pt-Cu precursor catalyst in the electrochemical formation of the active catalyst phase