Nanocatalysts at work

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In order to comprehend the properties affecting the catalytic performance of metal nanoparticles (NPs), their dynamic nature and response to the environment must be taken into consideration. The working state of a NP catalyst might not be the state in which the catalyst was prepared, but a structural and/or chemical isomer that adapted to the particular reaction conditions. This work provides examples of recent advances in the preparation and characterization of NP catalysts with well-defined sizes and shapes. It discusses how to resolve the shape of nm-sized Pt, Au, Pd, Cu, and PtNi catalysts via a combination of *in situ* microscopy (AFM, STM, TEM), *operando* spectroscopy (XAFS, GISAXS) and modeling, and how to follow its evolution under different gaseous or liquid chemical environments and in the course of a reaction. It will be highlighted that for structure-sensitive reactions, catalytic properties such as the reaction rates, onset reaction temperature, activity, selectivity and stability against sintering can be tuned through controlled synthesis. Examples of catalytic processes which will be discussed include the gas-phase oxidation of alcohols (methanol, propanol, butanol), the oxidation of NO, and the electrochemical reduction of CO_2. Emphasis will be given to elucidating the role of the NP size, shape and chemical state in the activity and selectivity of the former reactions.

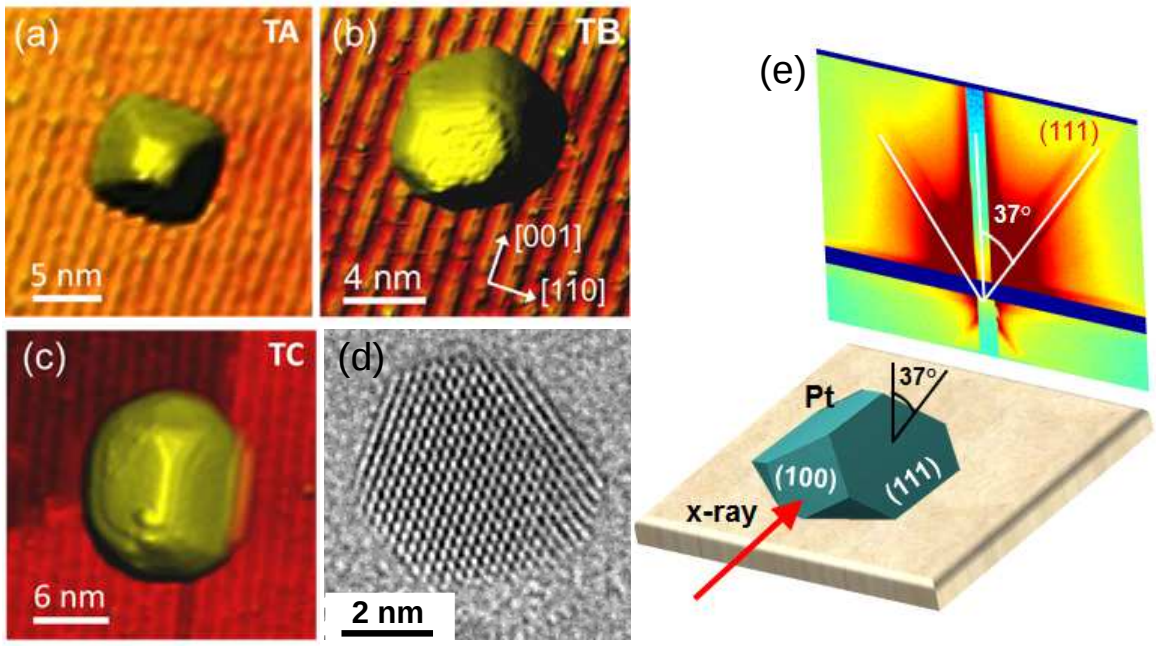

Fig. 1. (a-c) STM images of micellar Pt NPs on TiO_2(110) acquired at RT after annealing in UHV at 1000°C. (d) High resolution TEM image of a Pt NP deposited on SiO_2/Si obtained at RT after annealing at 800°C in H_2. (e) GISAXS data from shape-selected Pt NPs on $SrTiO_3$(110) acquired in H_2 at 700°C.