Physico-chemical nanomaterials science

The effect of reduction on the efficiency of platinum group metal/transition oxide catalysts

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The catalytic oxidation reactions are stimulated by the presence of nanometer sized particles of platinum group metals. Frequently, catalytic scientists operate with solid catalysts that are by default a complex solid matter containing nm particles supported on the edge structures of transition metal oxides. It is known that oxides support for the preparation of an efficient oxidation catalyst should have a size less than about 100 nm. The latter provides the convenient scale for decorating with metal particles with dimensions of ca. 10 nm. This type of catalysts is quite effective in many reactions that pass in a liquid phase. In contrast to the liquid phase reaction, the use of such catalysts in heterogeneous reaction taking place at gas vapor-solid interface can lead to deterioration of catalysts and errosion of the catalyst's mass. For this purpose we report here on specially prepared complex oxide materials with supported active mass of nm scaled platinum group metals. These catalysts include 0.1 to 0.5 mass% of platinum or palladium metals and catalyzed effectively the oxidation reaction in a flow reactor at atmospheric pressure. For small molecules oxidation reactions, the effect of reduction on the catalysts performance is disclosed and advanced catalysts having a high thermal resistance were obtained. The catalytic oxidation reaction was examined for the lean hydrogen, carbon monoxide or methane mixtures with air. These air mixtures mimicked the composition of a numerous industrial exhaust and lean gasses. The high active catalysts state maintains for about 100 reaction cycles. Transmission electron microscopy and scanning electron microscopy imaging were used to visualize nanoparticles of platinum group metals and surface interface morphology. The metals dimension shows a non-discrete distribution. The hydrogen, carbon monoxide or methane conversion vs. temperature shows a similar trend within the group of catalysts that indicates on the synergetic work of transition oxide and platinum metal nanoparticles. This trend caused the rearrangements of the oxide surface layer at the stage of the catalyst preparation. The significant activity at the heterogeneous catalytic reaction supports the assumption that strong-metal support interaction plays a main role in the catalysis with platinum metal nanoparticles that decorated reduced transition metal oxide surface.