Catalytic Engineering Studies of NH_3 Oxidation on Platinum

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Ammonia (NH_3) is a very important molecule with conflicting roles. On the one hand, NH_3 is a commodity chemical; its manufacture is integral to the production of fertilizers and polyamides. The oxidation of NH_3 on Platinum to NO_x (x = 1, 2) is one of the oldest commercialized catalytic reactions; it is the basis for the Ostwald Process for the manufacture of nitric acid. On the other hand, NH_3 has emerged as an important reagent in emission control. For the first generation of catalytic converters, NH_3 was an inconvenient byproduct and converter design changes were made to minimize its production. For the modern diesel vehicle, NH_3 is the NO_x reductant of choice. However, due to NH_3 toxicity, the NOx reduction must be accomplished without releasing NH_3 to the environment by Pt-catalyzed NH_3 oxidation. While the Ostwald process relies on high NO_x yield, the diesel emission control application requires a high N_2 yield.

In this talk we will describe our research in the understanding and design of the structured ammonia slip catalyst (ASC), wherein an NH_3 oxidation function is combined with a selective catalytic reduction (SCR) function. We show that a combination of targeted experiments and modeling enable convergence to an optimal architecture that minimizes the Pt loading We will also describe advances in the understanding and modeling of NH_3 oxidation kinetics, linking the environmental and chemical manufacturing applications. Finally, we will present a novel core-shell catalyst that comprises a Pt/Al_2O_3 core and a SCR shell provide for unparalleled ammonia oxidation activity and N_2 selectivity.