Environmental Catalysts for Treatment of Volatile Organic Compounds

By

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Abstract

Volatile organic compounds (VOCs) are an important type of indoor air pollutant that threatens both environment and human health. Catalytic remediation is an attractive method for treating VOCs, but most catalysts are insufficiently active at low temperatures (<200 °C) or in humid environments. This work combines both experiment and studies of the catalytic mechanism to identify the candidate catalytic materials. Cerium oxide and titanium dioxide were employed as support materials. Vanadia and nano-gold/platinum/palladium catalysts were deposited on these materials to enhance the catalytic performance. Operando methodology was employed to study the relationship between catalytic performance and adsorption of VOCs at the active sites. Aerogel technology was introduced to improve the catalytic activity in humid condition. Ceria-silica aerogel with a large surface area (ca. 300-500 m²·g⁻¹) and well dispersed ceria clusters demonstrates stable activity in the presence of water vapor, overcoming the decline in catalytic activity caused by humidity. In addition, the transition metal oxides derived from metal organic frameworks (MOFs) were investigated systematically for remediation of VOCs. The light-off temperatures are all less than 200 °C for metal oxides such as MnOₓ, Co₃O₄, CuO, and CeO₂ derived from Mn-BDC, ZIF-67, CuBDC, and CeBDC, respectively. The 2D rhombic binary metal oxides CeCuOₓ derived by pyrolysis of bimetallic CeCu-MOF exhibits extremely high activity and selectivity oxidizing toluene with T₅₀ and T₉₀ (temperatures for 50% and 90% conversion) at 150 °C and 185 °C respectively.