Two Catalysts for Selective Oxidation of Contaminant Gases

One oxidizes halocarbons and ammonia; the other oxidizes ammonia.

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Two catalysts for the selective oxidation of trace amounts of contaminant gases in air have been developed for use aboard the International Space Station. These catalysts might also be useful for reducing concentrations of fumes in terrestrial industrial facilities — especially facilities that use halocarbons as solvents, refrigerant liquids, and foaming agents, as well as facilities that generate or utilize ammonia.

The first catalyst is of the supported-precious-metal type. This catalyst is highly active for the oxidation of halocarbons, hydrocarbons, and oxygenates at low concentrations in air. This catalyst is more active for the oxidation of hydrocarbons and halocarbons than are competing catalysts developed in recent years. This catalyst completely converts these airborne contaminant gases to carbon dioxide, water, and mineral acids that can be easily removed from the air, and does not make any chlorine gas in the process. The catalyst is thermally stable and is not poisoned by chlorine or fluorine atoms produced on its surface during the destruction of a halocarbon. In addition, the catalyst can selectively oxidize ammonia to nitrogen at a temperature between 200 and 260 °C, without making nitrogen oxides, which are toxic. The temperature of 260 °C is higher than the operational temperature of any other precious-metal catalyst that can selectively oxidize ammonia.

The purpose of the platinum in this catalyst is to oxidize hydrocarbons and to ensure that the oxidation of halocarbons goes to completion. However, the platinum exhibits little or no activity for initiating the destruction of halocarbons. Instead, the attack on the halocarbons is initiated by the support. The support also provides a high surface area for exposure of the platinum. Moreover, the support resists deactivation or destruction by halogens released during the destruction of halocarbons.

The second catalyst is of the supported-metal-oxide type. This catalyst can selectively oxidize ammonia to nitrogen at temperatures up to 400 °C, without producing nitrogen oxides. This catalyst converts ammonia completely to nitrogen, even when the concentration of ammonia is very low. No other catalyst is known to oxidize ammonia selectively at such a high temperature and low concentration. Both the metal oxide and the support contribute to the activity and selectivity of this catalyst.

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Nanoscale Metal Oxide Semiconductors for Gas Sensing

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A report describes the fabrication and testing of nanoscale metal oxide semiconductors (MOs) for gas and chemical sensing. This document examines the relationship between processing approaches and resulting sensor behavior. This is a core question related to a range of applications of nanotechnology and a number of different synthesis methods are discussed: thermal evaporation-condensation (TEC), controlled oxidation, and electrospinning. Advantages and limitations of each technique are listed, providing a processing overview to developers of nanotechnology-based systems.

The results of a significant amount of testing and comparison are also described. A comparison is made between SnO2, ZnO, and TiO2 single-crystal nanowires and SnO2 polycrystalline nanofibers for gas sensing. The TEC-synthesized single-crystal nanowires offer uniform crystal surfaces, resistance to sintering, and their synthesis may be done apart from the substrate. The TEC-produced nanowire response is very low, even at the operating temperature of 200 °C. In contrast, the electrospun polycrystalline nanofiber response is