Creation of Exotic Features in Metal Oxides by Surface Treatment for Enhanced Gas Sensing

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High selectivity, enhanced sensitivity, short response time and long shelf-life are some of the key features sought in the solid-state ceramic-based chemical sensors. Since the sensing mechanism and catalytic activity of ceramics are predominantly surface-dominated, benign surface features in terms of small grain size, large surface area and, open and connected porosity, are required to realize a successful device.

In the case of oxide ceramics, we have developed a technique based on rigorous thermodynamic consideration of the metal/metal oxide coexistence. In order to incorporate the required nanoscale morphological features, a gas phase redox scheme was adopted. Instead of the classical approach of reduction by H\textsubscript{2} and oxidation by O\textsubscript{2} or air, the metal oxide of interest is reduced and re-oxidized by exposing it to a well-defined pO\textsubscript{2} that is somewhat below (for reduction) and above (for re-oxidation) the theoretical M/MO coexistence line. Since the prevailing oxygen potential is only slightly above that established by virtue of thermodynamic equilibrium between M and MO\textsubscript{x} or between MO\textsubscript{x} and MO\textsubscript{y}, this allows the formation and growth of new oxide surface on an atomic/molecular level, under conditions of ‘oxygen starvation’.

Adopting this scheme, we have successfully created novel microstructures in a host of oxide systems with a view of imparting benign surface features that are paramount in accentuating their functional behavior in a host of applications. The presentation discusses the methodology and the CO sensing results obtained in the case of two such oxide systems, namely, MoO\textsubscript{3} and WO\textsubscript{3} films.