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Metal Oxide Oxygen Sensors for Automotive Applications

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Several concepts for controlling emissions and optimizing the performance of internal combustion engines are based on feedback control of the air/fuel ratio (A/F). Some of these systems rely on the existence of sensitive and reliable A/F sensors. The Ford Scientific Laboratory has been studying several metal oxides (*1–3*) in an effort to develop A/F sensors with the needed performance characteristics over a wide range of $A/F(P_{O_2} = 1 - 1 \times 10^{-20}$ atm). The emphasis of the work at Ford is on metal oxide A/F sensors that utilize the resistance change of a metal oxide with the ambient oxygen partial pressure (P_{O_2}). The operation of these devices involves a variety of physical processes that will be discussed. Some of these are not well understood, e.g., impurity effects, catalytic activity of oxides for gas reactions, phase changes, and effects characteristic of material with high surface-to-volume ratio (ceramics). Titanium dioxide and cobalt monoxide have been the most extensively investigated materials and results are presented on the high temperature electrical properties of pure and doped materials. The kinetics of equilibration that define the response time of the device have also been studied by electrical and optical techniques and results are presented that indicate the importance of the gas–solid surface reaction rates. The relation between material parameters and performance characteristics of a sensor is analyzed. Finally, results on the performance. of operational TiO_2 and CoO sensors are presented and discussed.

References

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