Development of Chemical Microsensors and Sensor Arrays for Emission, Leak, and Fire Detection

[1]G. W. Hunter, [1]P. G. Neudeck, [2]C.C. Liu, [2]B. J. Ward, [3]D. B. Makel, [4]J. Xu
[1]NASA Glenn Research Center at Lewis Field, Cleveland, OH
[2]Case Western Reserve University, Cleveland, OH
[3]Makel Engineering, Chico, CA
[4]QSS Inc., Cleveland, OH

ABSTRACT

The aerospace industry requires the development of a range of chemical sensor technologies for such applications as emission monitoring, fuel leak detection, and fire detection. This paper discusses the development of microfabricated sensors and sensor arrays based on: 1) Micromachining and microfabrication technology, 2) The use of nanocrystalline materials, and 3) The development of high temperature semiconductors, especially silicon carbide.

These sensors are intended to measure gaseous chemical species such as hydrocarbons, nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) in a range of environments. However, individual sensors are limited in the amount of information that they can provide in environments that contain multiple chemical species. Thus, microsensor arrays are being developed to address detection needs in such multi-species environments. The development and potential implementation of these sensors and sensor arrays for emission, fire, and leak detection applications is the topic of this paper.

For example, development of a sensor array for high temperature, emission sensing applications (a High Temperature Electronic Nose) has begun. Figure 1 shows the response of a tin oxide based sensor (doped for NO_x sensitivity), an oxygen sensor, and a SiC-based hydrocarbon sensor. The figure shows the individual sensor responses during different engine operational conditions and corresponding values of Phi (the fuel-air equivalence ratio or the fuel-air mass ratio divided by the stoichiometric fuel-air mass ratio). Each sensor has a different characteristic response and these results are qualitatively consistent with what would be expected for this type of engine. They also show the value of using sensors with very different response mechanisms in an electronic nose array: the information provided by each sensor was unique and monitored a different aspect of the engine's chemical behavior. Microsensor arrays for use in this emissions as well as leak and fire detection applications will be discussed.

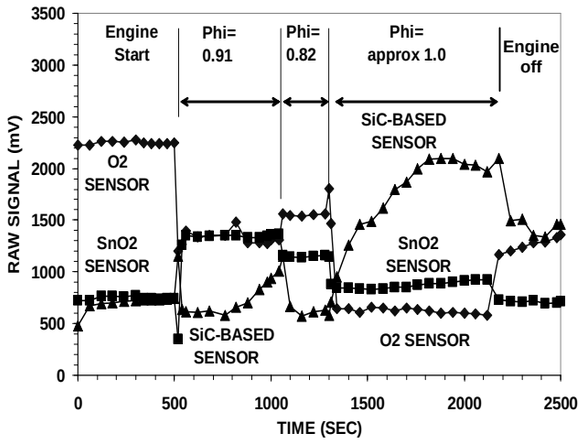

Figure 1. The response of a sensor array composed of a tin oxide based sensor, an oxygen sensor, and a SiC-based hydrocarbon sensor in an engine environment.