Hyperspectral Plasmonics Based Harsh Environment Compatible Chemical Sensors

Michael A. Carpenter
College of Nanoscale Science and Engineering, University at Albany-SUNY, Albany, NY
mcarpenter@albany.edu

The surface plasmon resonance band of gold nanoparticles embedded in metal oxide heterostructure films is used as an optical beacon for the detection of emission gases, CO, NO$_2$, and H$_2$, at temperatures ranging between 500 and 800°C. A summary of previous experiments detailing the sensing characteristics will be provided. A challenge for the detection of emission gases is not only high levels of sensitivity but the selective detection of the gas of interest.

Recent work will be detailed which shows the implementation of plasmonic based sensing arrays for the detection of emission gases. The array is based on Au nanoparticles embedded in either yttria stabilized zirconia, ceria or titania metal oxide thin films. These multiple plasmonic sensing elements within the array are probed simultaneously to characterize the selective detection characteristics of the array. A plot of the plasmon peak position as a function of the target gas concentration shows a reversible and reliable response with 50+ hour experiments.

Principle components analysis (PCA) is used as a hyperspectral multivariate method to gauge the inherent selectivity of the film between the separate analytes. The use of PCA provides a unique and identifiable response seen for each of the target analytes.

Variations in nanoparticle size and shape as well as the metal oxide matrix chemistry are being varied to produce next generation sensing arrays with enhanced selective sensing properties. Detailed studies are also underway which characterize the sensing response as a function temperature as well as a probe of the interfacial surface chemistry via Raman spectroscopy.

Figure 1. Sensing data plot of the plasmon peak position as a function of time and target gas exposure.

Figure 2. PC scores plot for Au nanoparticle sensing array