High Temperature Selective Gas Sensing Using the Plasmonic Response from Au / Metal Oxide Nanocomposite Films

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Thin metal oxide films embedded with Au nanoparticles (AuNPs) are being investigated as high temperature plasmonic sensing devices to monitor combustion emissions. The application is targeted towards turbine engines where emission products are regulated, but the measurement of these emissions is challenging due to the harsh exposure conditions. Our approach to meet the sensing needs is an optical technique based upon the plasmonic properties of AuNPs. Previous work has shown that AuNPs are stable up to 700°C when embedded in a metal oxide matrix. By monitoring the localized surface plasmon resonance (LSPR) peak position in the absorbance spectrum, the detection of H_2, NO_2, and CO has been demonstrated and attributed to changes in the free electron density on the AuNPs and the refractive index of the metal oxide matrix. One of the main challenges is to achieve a selective sensing response towards the target gases from these nanocomposite films. One way to evaluate this is through the use of multivariate analysis in order to extract the most gas-selective information from the sensing response. In addition to that, a materials approach can be taken where several different nanocomposite films are combined in an array with each film contributing to the overall selective response.

In this talk I will briefly cover both data analysis and materials development for selective sensing. First, H_2, CO, and NO_2 sensing results from a single Au-CeO_2 film will be discussed in the context of principal component analysis (PCA). PCA is a multivariate technique of dimensional reduction that minimizes loss of information and allows the maximum variance (or sensor response) to be displayed graphically as shown in Fig. 1. Second, materials development initiatives will be discussed. The aim of this part of the project is to improve selective sensing response by combining the Au-CeO_2 film with a Au-YSZ (yttria stabilized zirconia) and Au-TiO_2 film. Comparison of the array with a single sensing film is done qualitatively using PCA.

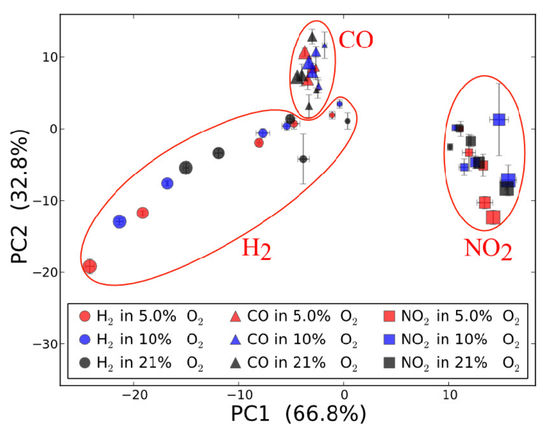

Fig. 1: Principal components plot of PC 1 vs. 2 for a Au-CeO_2 nanocomposite film.