Abstract

In the present work, atmospheric plasma spray technique was used to develop gas sensor (SnO_2, WO_3-SnO_2 composites, and CuO), and catalyst (CuO) layers. Two different sensing protocols, namely, quasi-static and dynamic flow were used to investigate the sensing characteristics of these plasma sprayed coatings. Initially, two different SnO_2 coatings of identical thickness were made using nitrogen and nitrogen-10 vol. % hydrogen as plasma forming gases, respectively. C_2H_5OH sensing characteristics of both these coatings were tested using a quasi-static gas sensing setup. The coating made using nitrogen as plasma forming gas exhibited superior sensing response % as compared to the coated layer prepared using the other plasma forming gas. The response % in the presence of C_2H_5OH test gas was superior as compared to CH_3COCH_3 and i-C_3H_7OH. To better understand the sensing behavior, temperature dependent sensor response was modeled using gas diffusion theory which follows first order kinetics and Knudsen diffusion. WO_3-75 wt. % SnO_2 composite coating was tested using a quasi-static gas sensing setup. The response % in the presence of C_2H_5OH was higher as compared to that of CH_3COCH_3 and i-C_3H_7OH. Concentration dependent conductance transients for three analytes were analyzed using Freundlich adsorption isotherm. Subsequently, H_2 and CO sensing characteristics of two different coating configurations, namely, SnO_2 layer with bottom electrodes and SnO_2 layer with top electrodes were tested using a dynamic flow gas sensing set up. Both SnO_2 coatings yielded higher H_2 response % as compared to CO response %. Concentration dependent conductance transients for H_2, CO sensing were analysed following Langmuir adsorption isotherm. CO sensing performance of CuO coating was tested using a dynamic flow gas sensing setup. Since the response % in the presence of CO was much superior to that for i-C_4H_{10}, CH_4, and NO_2 gases; this coating is claimed suitable for selective CO sensing. Using a fabricated set-up, the efficacy of CuO catalyst coating was tested for gasoline engine exhaust. CO, HC and NO_x emissions were reduced by ~80 %. Useful sensor response, catalytic conversion results could be attributed to porous surface morphology with inter-granular contacts conducive to adsorption/desorption of oxygen and test gas.

Keywords: atmospheric plasma spray; sensor; gas detection; selectivity; gas diffusion theory; conductance transients; adsorption isotherm; catalyst, gasoline engine emission control.