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Thin film Ceria Using RF Sputtering on Metal Fibers for Catalyzing Diesel Soot Oxidation

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Diesel powered vehicles are widely used in the developing world, including Thailand where light-duty diesel trucks alone make up over a third of the private automotive market share. This is because of diesel engines have a relatively high thermal efficiency and fuel economy. But this also contributes significantly to the local pollution due to the harmful emissions from diesel combustion, especially particulate matter (PM). To reduce these emissions diesel oxidation catalysts (DOC) and diesel particulate filters (DPF) are used, usually together. To save space in the engine bay, these two components can be combined by applying a catalyst coating on the DPFs. This catalyst coating can also help oxidize PM when it gets trapped by the filter material. This coating can be done using various methods but to reduce the impact of the coating on the filtering performance, a thin layer coating method is desired. An excellent method of coating a thin layer is to use physical vapor deposition (PVD). This research explored coating Ceria on the surface of a metal fleece that makes up the filtering material in a partial flow DPF.

The PVD was done by RF sputtering using a CeO_2 ceramic target. This target was first used on Si wafers to confirm the coating would be CeO2 instead of Ce2O3. The wafers also allowed a determination of the deposition time required to obtain the final coating. The final coating was around 350nm in thickness. This final coating used a 150W power source and was done with the fleece at room temperature but with a bias of -10V. The deposition atmosphere was Ar and the base pressure was 70 mtorr while the deposition pressure was 6.3 x10^{-2} mbar. Fig. 1 shows the coated metal fiber.

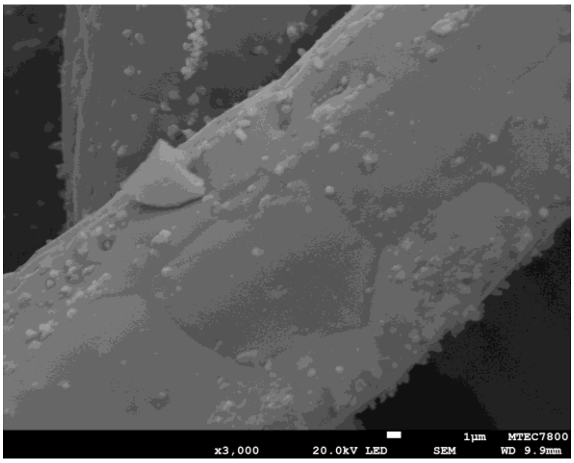

Fig.1 Coated metal fiber

TGA was done with CBN330 and diesel PM on the non-coated and coated metal fleece to determine the effect of the catalyst on oxidizing soot and also for how it affected differently structured soot. Non-isothermal and isothermal TGA were used. Fig.2 shows the mass conversion of diesel PM on the non-coated and coated fleece. It can be seen that the coating allowed faster oxidation of the hydrocarbon and sooner start of the carbon oxidation. The isothermal method was also used to determine the activation energies of oxidizing the soots. They were 167 kJ/mol and 138 kJ/mol for CBN330 on non-coated and coated metal fleece. For the diesel PM on non-coated and coated, the activation energies were 128 kJ/mol and 90 kJ/mol respectively. The coating reduced the activation energy by 17% and 30% for CBN330 and diesel PM, respectively.

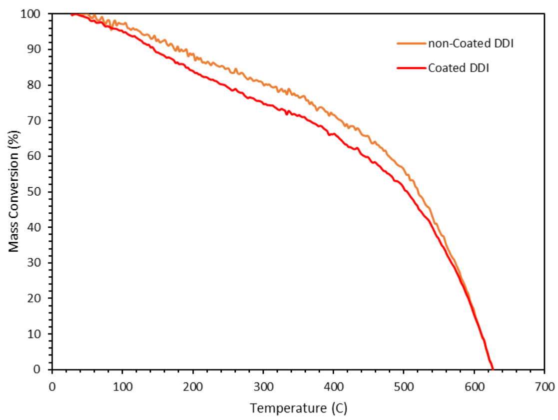

Fig.2 Mass conversion of diesel PM on non-coated fleece and coated fleece