Structure – Activity Interrelationships of Combustion Synthesis Catalysts for the Oxidation of Diesel Soot

G. Xanthopoulou and G. Vekinis

Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", 15310, Greece[i]

Atmospheric aerosol particles are considered air pollutants because of their impact on the environment, climate and public health, including in-vitro mammalian cell chromosomal and DNA damage. Among such pollutants, diesel particulate matter (DPM) or diesel soot, primarily composed of carbon, has a significant adverse impact on both global warming and public health. DPM is typically trapped using diesel particulate filters (DPFs), which are periodically regenerated to oxidize the accumulated soot particulates. Because of the highly complex nature, ambiguity, and unpredictability of the multicomponent soot structure, as well as varying diesel engine operating conditions, optimized DPF operation and regeneration is a challenging task and parallel catalytic oxidation of the soot would offer definite advantages.

This work presents the results of an investigation on the structure-catalytic activity interrelationships for a range of combustion synthesis catalysts tested for oxidation of three different types of soot: diesel engine, activated carbon and heating burner. The catalytic activity of any catalyst depends on microstructure, but also on their redox behavior and lattice oxygen mobility. To study such dependencies, various catalytic materials were synthesised using Solution Combustion Synthesis (SCS) from aqueous solutions of manganese and cerium nitrates, copper potassium dichromate, chromium oxide (VI) and urea at a preheating temperature of 500 ^{o}C. The synthesised catalysts were characterized by SEM/EDAX, XRD, and nitrogen porosimetry. Their catalytic performance was studied in air flow at 1l/minat a heating rate of 10^{o}C/min. In all cases a soot:catalyst mixture of 1:3, was placed in a ceramic reactor and the temperature for initiation and completion of oxidation was determined. It was found that crystallite size (fig.1) and lattice d spacing catalysts (fig.2) correlate with their activity. Other parameters found to correlate with the catalytic activity were the initial primary particle size, specific surface area, and crystallite stacking height in a self-consistent way.

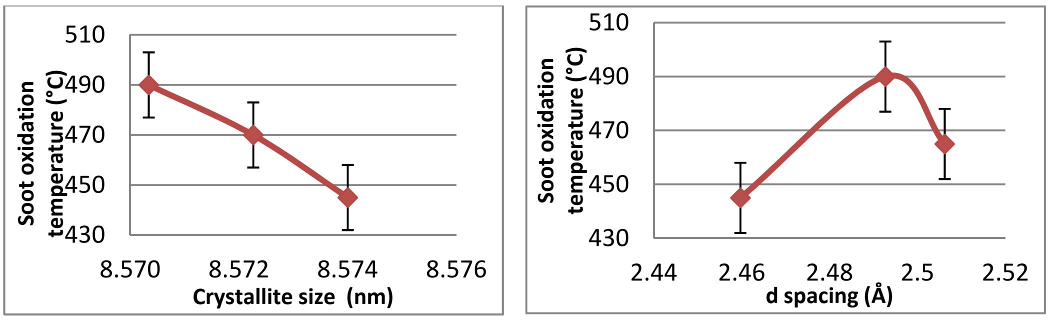

Fig.1 Influence of crystallite size of grains (D) at combustion temperatures of diesel soot, SCS Co-Ce-O catalyst. Influence of CuCrO2 crystal structure parameters (d) of SCS Cu-K-Cr-O catalyst on the combustion temperatures of diesel soot

[i] gxantho@ims.demokritos.gr