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Aerosol Based Functionalization of Porous Substrates for Diesel Particulate Emission Control Applications within the ATLANTIS project

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A great number of porous media based on various materials (oxide and non-oxide ceramics, sintered metal powders and metal and ceramic textile/fabrics) have been developed for diesel particulate emission control applications, such as diesel particulate filters (DPF). However, certain problems (e.g. inadequate durability, short lifetime and high cost) continue to represent important challenges that trigger the development of new filter materials. Suitably engineered and functionalised porous materials can therefore bring important breakthroughs in the above areas. Motivated by this fact, the European project ATLANTIS is underway, in which the goal is to develop a highly efficient and multifunctional (simultaneous gaseous and particulate pollutants removal) emission control system for future Diesel powered engines.

The present work reports on one of the objectives of the ATLANTIS project, namely the creation of a data base of porous materials/structures (characterized with an array of techniques) that will provide the building blocks for future Diesel emission control applications, including DPFs. The base materials for these porous building blocks are ceramic powders, metal fibers and ceramic fibers of different compositions. These can then be used in various (2-D and 3-D) shaping processes to produce sintered sheets and textile fabrics, foams and multichannel structures, with spatially tuned pore structure and geometries.

The developed porous media are being evaluated for automotive applications in two steps firstly as bare samples and secondly as functionalized samples via Aerosol Infiltration-Deposition (AID) processes, originally introduced in this field by Karadimitra *et al*. (2001).

Screening tests are performed at the laboratory scale and in Diesel engine exhaust to evaluate the following properties of the porous samples: a) flow resistance, b) filtration efficiency and c) soot loading behaviour d) direct (oxygen-based) and e) indirect (NO_2-assisted) soot oxidation activity. This creates a five-dimensional space where, regions of “acceptable” and “unacceptable” performance can be identified and trade-offs with respect to different performance criteria may be assessed. A set of promising porous materials and structures has thus been identified for further functionalization. The functionalization at the present stage focuses on identifying a suitable soot oxidation catalyst, while gas treatment catalytic functions will follow soon after. A wide variety of soot oxidation catalyst formulations has been synthesized via aerosol synthesis routes, and the most promising formulations were subsequently coated on the selected porous structures and evaluated on a Diesel engine exhaust set-up.

Indicative results with respect to indirect soot oxidation are shown in Figure 1 for AID-coated SiC and Al_2O_3 wall-flow monoliths. It can be seen that both monoliths reduce the soot oxidation temperature from the uncoated sample, however, the reduction on the SiC monolith, is higher.

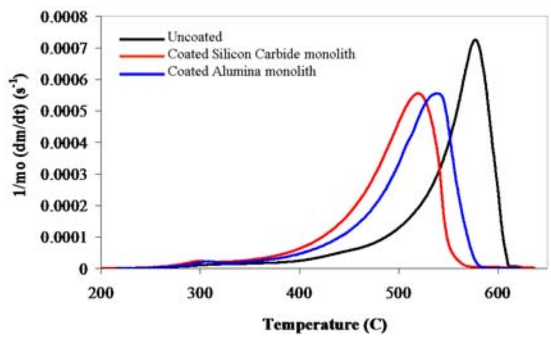

Figure 1. Indirect soot oxidation on coated SiC and Al_2O_3 wall flow monoliths by a flow containing 300 ppm of NO.

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Karadimitra, K., Macheridou, G., Papaioannou, E. & Konstandopoulos, A. G. (2001). in *Proc. Partec 2001*, Paper No 135.