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Novel diesel particulate filters containing fine ceramic fibres

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Ongoing concerns about adverse health effects of carbon particulate in Diesel engine exhausts continue to drive the quest for improvement performance from Diesel Particulate Filter (DPF) systems for their removal. Two of the main areas in which improvements are being sought are enhanced removal of very fine particles (<~50nm), particularly during the period immediately after regeneration (removal of accumulated particulate via combustion), and improved thermo-mechanical stability - especially in terms of resistance to thermal shock (during regeneration). The latter is focused partly on raising the fracture toughness of the materials concerned. One approach to achieving these aims is to create novel composite materials via the introduction of (ceramic) fibres. This has the potential both to enhance the fracture toughness, mainly by promoting fibre pull-out, and to improve the filtration efficiency by creating "hybrid" (multi-scale) structures, with some gas flowing through very fine channels, while the presence of other (relatively coarse) pathways ensures that the overall permeability remains acceptably high. For DPFs, the latter requirement corresponds to the specific permeability being no lower than about ~10-12 m^2. This presentation covers the creation of novel DPF structures containing fine ceramic fibres and measurement of their porosity, permeability and fracture toughness. Work is also presented on tomographic capture of DPF structures (using a Simpleware package) and simulation of the flow through them of hot gas containing fine carbon particulate (using COMSOL packages. It is concluded that there is scope for significant improvement in overall DPF performance via the incorporation of fine fibres.

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