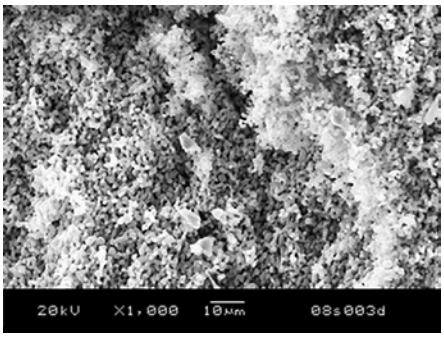
EMSL Science Made Possible

Fine-tuning diesel particulate filters

Targeting the particles that tarnish diesel's clean, green reputation

A team of researchers from the Pacific Northwest National Laboratory used integrated computational and experimental resources at the Department of Energy's EMSL to investigate the ability of two types of diesel particulate filters (DPFs)—silicon carbide and cordierite—to trap small particles that diesel engines emit into our air. Consumers are enamored with the higher fuel efficiency diesel engines afford, but are put off by the higher exhaust particulate matter, or soot, diesel produces. Presently, DPFs are the most efficient means to trap the soot. EMSL researchers conducted a direct comparison between silicon carbide and cordierite DPFs as well as between experimental data and existing models that aim to predict DPF filtration efficiency and pressure drop. Nearly spherical laboratory-generated ammonium sulfate particles were used as soot surrogate in this study; they are ideally suited for comparing experimental results to computational simulations that treat soot agglomerates as spherical. To what extent these simplifications impact the accuracy of DPF simulations remains an open question.



Scanning electron microscopy image of a single wall cordierite filter that was loaded with ammonium sulfate particles for 18 hours. The particles trapped on top of the filter form a thick cake.

The study theoretically modeled and experimentally tested the two ways in which filters block particulate matter. First, particles are captured in the filter holes; second, longer exposure causes the particles to form a dense "soot cake" on which particles are efficiently trapped. The researchers showed that the transition from filter capture "soot cake" can be identified by recording the change in pressure across the filters as a function of particle loading and that the filters trap small and large particles better than particles that are ~80 to 200 nm in aerodynamic diameter. Comparing experimental data and a simulation showed that the models overpredict the filter's trapping efficiency, and as a result they also predict shallower penetration than that observed in the experiment. The team will travel to Wisconsin to collaborate with General Motors and the University of Wisconsin researchers to investigate the behavior of DPFs when exposed to laboratory-generated soot particles and particles emitted by diesel engines under various operating conditions. The collaborators plan to characterize the physical and chemical properties of particle matters using EMSL's Single-Particle Mass Spectrometer, SPLAT II.

Scientific impacts: These studies use a fundamental scientific approach to understand issues related to clean energy production and use. The work supports the need for energy-efficient diesel and illustrates the value of closely linking experimental and theoretical methods to address environmental issues.

Societal impact: Investigating how DPFs trap particles has future potential to help manufacturers build better filters, a critical step toward tackling diesel exhaust emissions, leading to less air pollution.

For more information, contact EMSL Communications Manager Mary Ann Showalter (509-371-6017).

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User Proposals: 17803 and 25637