Advanced Metallographic Techniques Applied to Diesel Particulate Filters

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https://doi.org/10.1017/S1551929500061253 Published online by Cambridge University Press

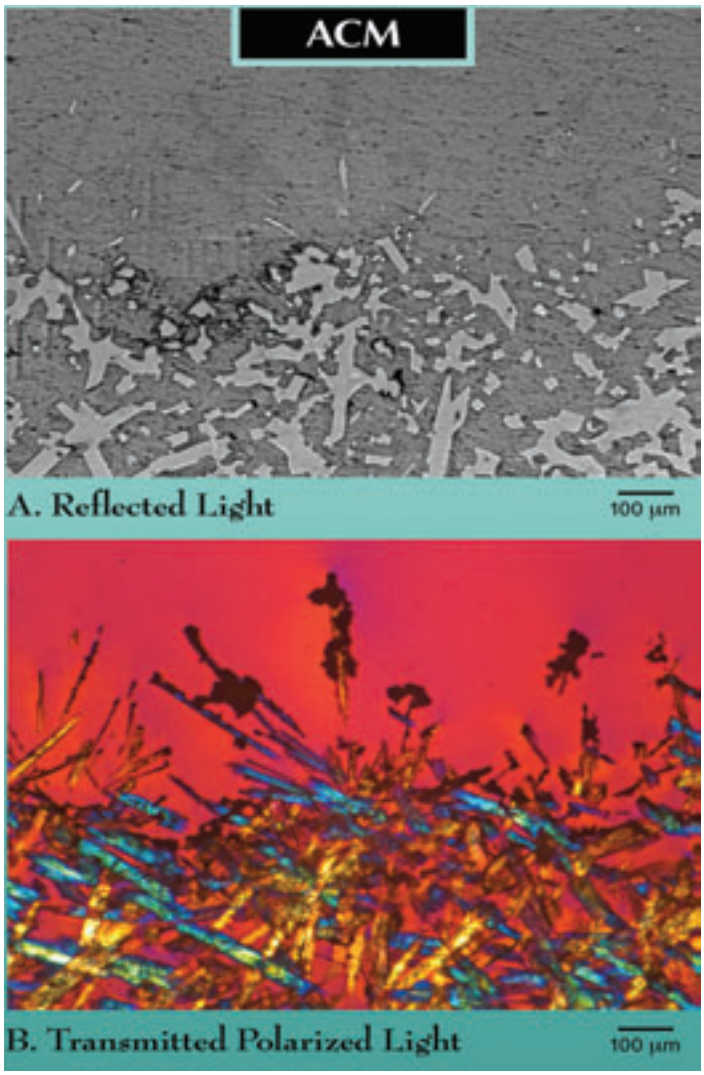
Project Overview

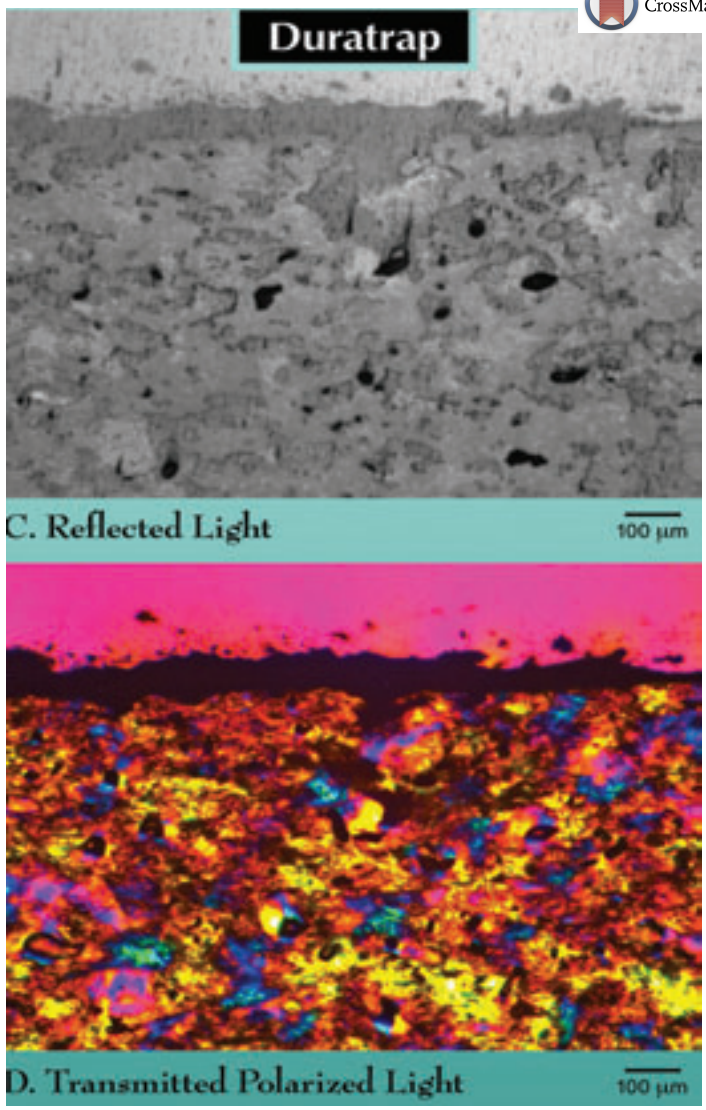
Diesel Particulate Filters (DPFs) are designed to capture exhaust particulates from engines. The filter material collects the particulates deep in the substrate (deep-bed filtration) before transitioning to other filtration methods on the surface. The deep-bed filtration has been characterized by modeling studies but little experimental information about the particulate, or soot, penetration in the filter material is available. Traditional evaluation methods do not provide sufficient contrast between the soot and mounting resins.

Sample Preparation

Due to the difficulty of locating carbon soot in the pores in these filters, ultra-thin section techniques (under 10-micron-thick sections) were used for the characterization of these samples. Under transmitted light, the carbon soot is black because it blocks the light, and the carbon in the resin material is relatively clear.

Samples were initially prepared by vacuum impregnating with a low viscosity thermosetting epoxy. The mounted samples were prepared using semi-automatic polishing machines in conjunction with grinding and polishing steps down to 1-micron diamond abrasive polish. After the mounted sample is polished, the mounted sample is sliced with a diamond saw to produce a thin wafer approximately 1-cm thick, having a surface parallel to the originally polished surface. This thin wafer is then vacuum impregnated using epoxy resin and then mounting the polished side down contacting the petrographic glass side. The top or cut surface is then ground to approximately 20 microns using semi-automatic polishing machines and diamond abrasives, this is followed by vibratory polishing on a napless cloth and 1-micron diamond abrasive until the desired thickness is achieved.





Results

In this experiment, two types of substrate materials are examined using a thin section technique. An Advanced Ceramic Material (ACM) is shown in Figures A and B, with characteristic needle formations in the substrate and a more traditional Duratrap substrate is shown in Figures C and D. For the ACM the carbon soot capture (black) is shown on the edges of the needles (Figure B) and also within the substrate. The Duratrap material shows the early formation of the surface soot layer on the top of the substrate and penetration of soot into the pores (Figure D).

Conclusion

By preparing the diesel filter using thin-sectioning techniques, researchers use transmitted light to distinguish the soot from the carbon in the mounting material. This procedure allows researchers to evaluate the efficacy of the diesel filters at a glance. ■

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