High Performance DPF Development and Its Application

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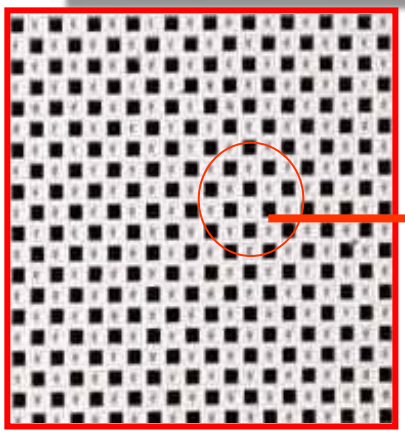
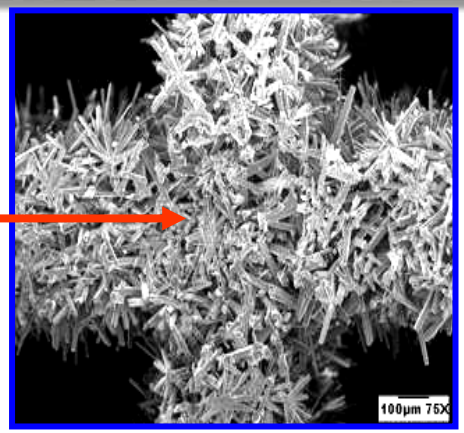
DPF made from High porosity Advanced Ceramic Material





ACM - honeycomb wall porosity:	60± 2 %
Honeycomb cell density:	200 cpsi
Honeycomb wall thickness:	~ 14 mil
Substrate density	0.5 kg/L
Melting temperature:	> 1600 deg C
Elastic Modulus of wall material (25°C):	~ 20 Gpa
Poisson's ratio of wall material (25°C):	0.18 – 0.22
MOR of wall material (25°C, av max bending strength):	30 MPa
Thermal conductivity (1000°C)	1.1 W/m-K

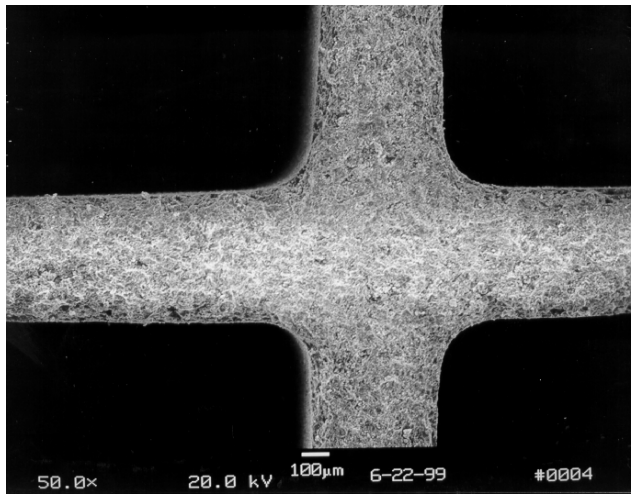
Coefficient of Thermal Expansion:

Temperature (°C)	C.T.E. (10^{-6} / °C)
200	3.95
600	4.95
1000	5.50
1200	5.70

High Mechanical Performance Deep Bed Filtration

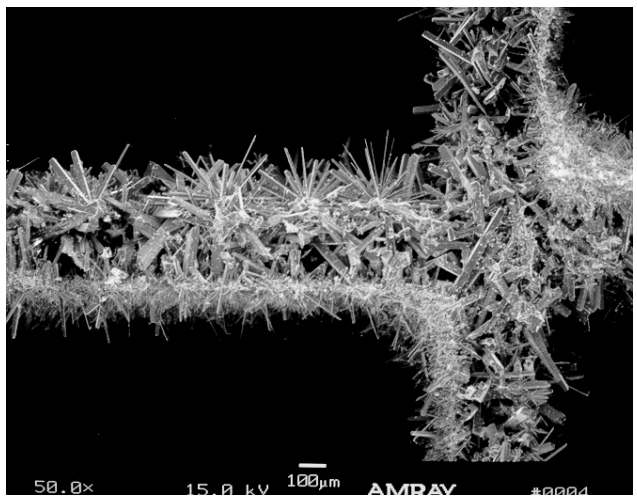
Conventional Materials (Cordierite or SiC)

- ~ 45% porosity
- "pile-of-stones" microstructure



Advance Ceramic

- ~60% porosity
- "pile-of-sticks" microstructure
- interlocked felt of single crystal needles



Washington Monument
Height: 555 ft., Weight: 90,000 tons

Eiffel Tower
Height:: 984 ft., Weight: 7,000 tons

High Chemical Resistance

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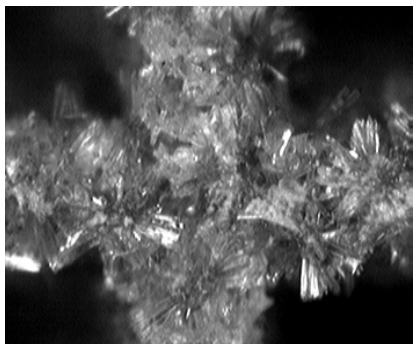
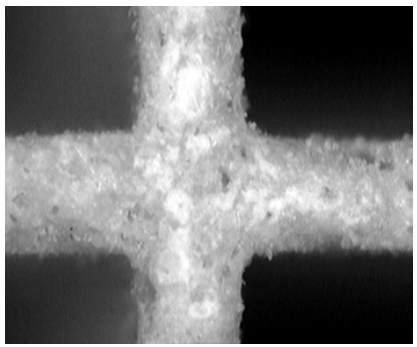
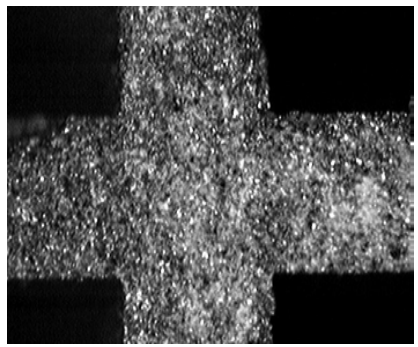
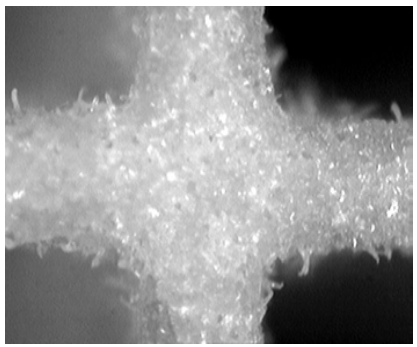
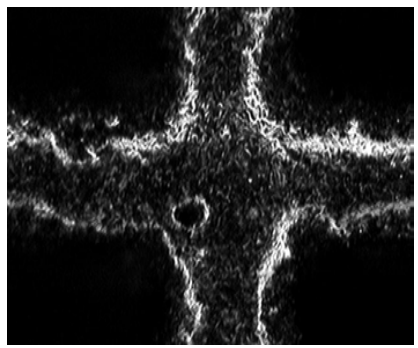
	ACM	Cordierite	SiC
Before			
After		Sample evaporated	

NaCl powder deposited on the filter surface then heated to 1300° C for 5 hrs

High Performance of ACM DPF –Engine validation

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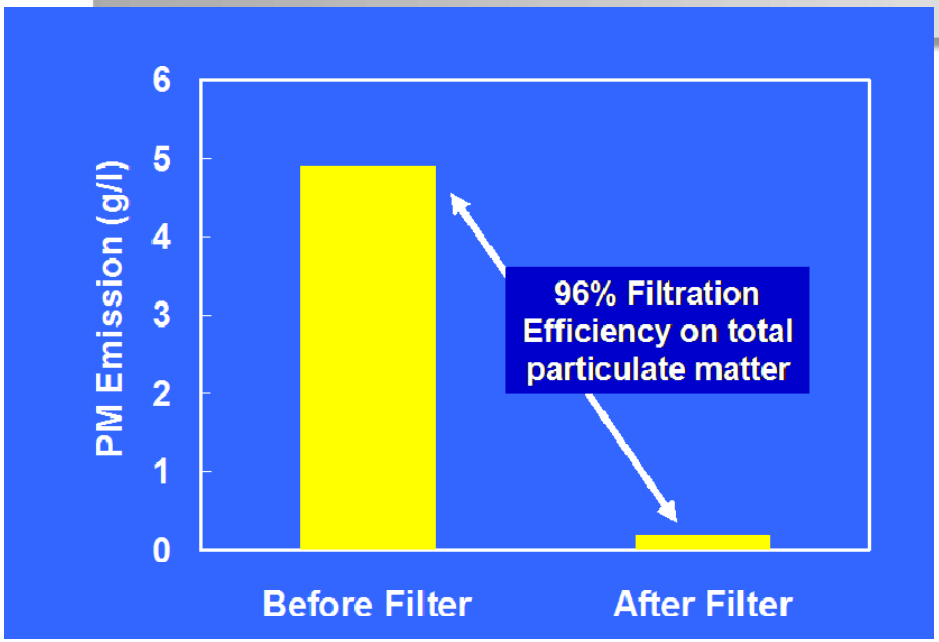
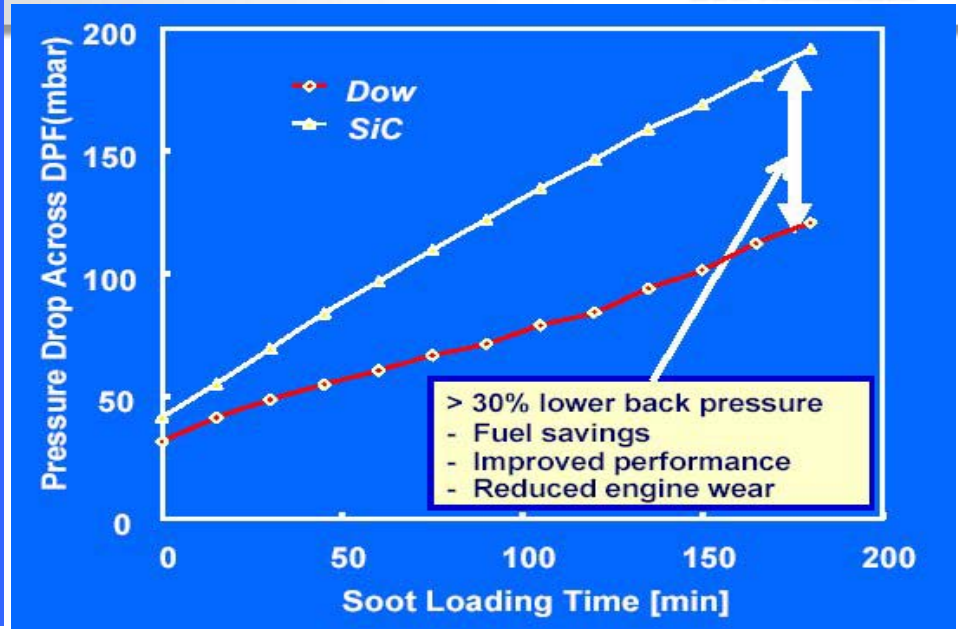
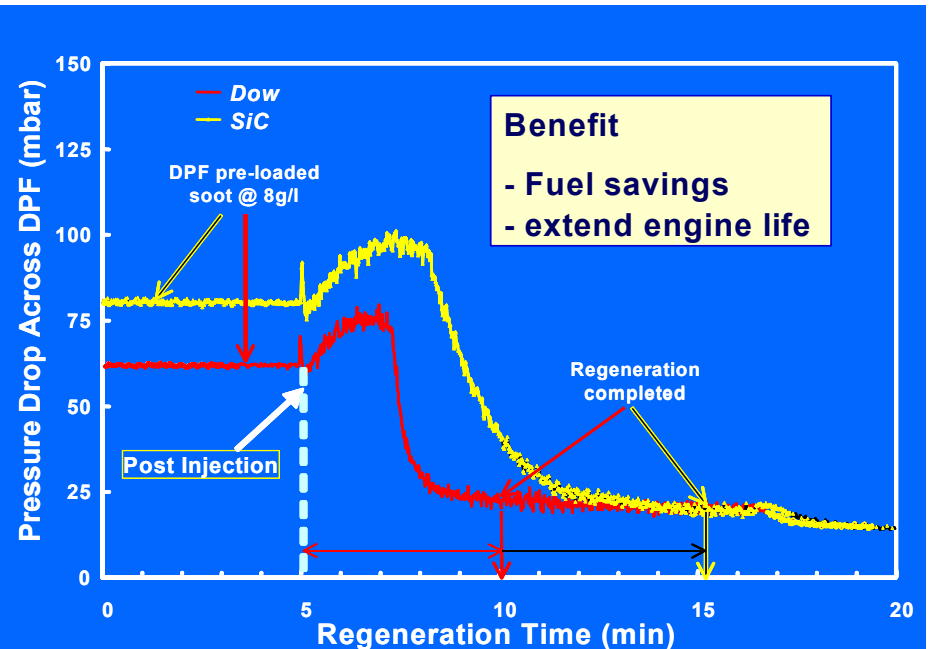
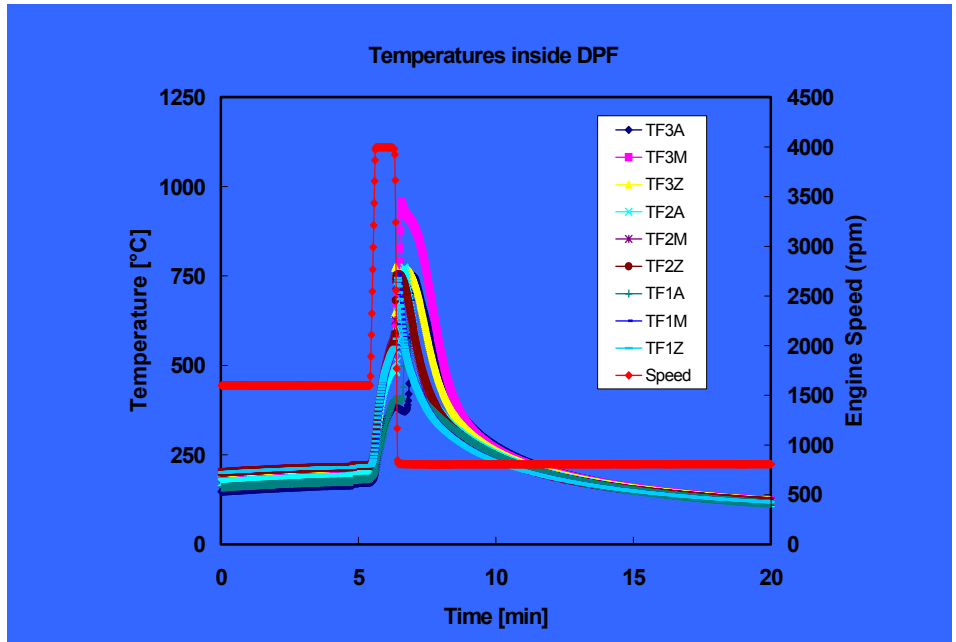
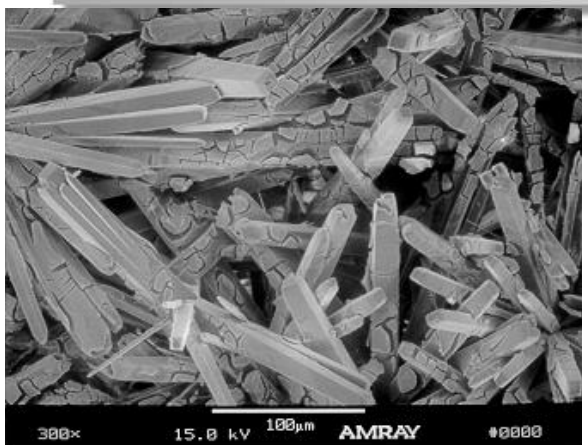




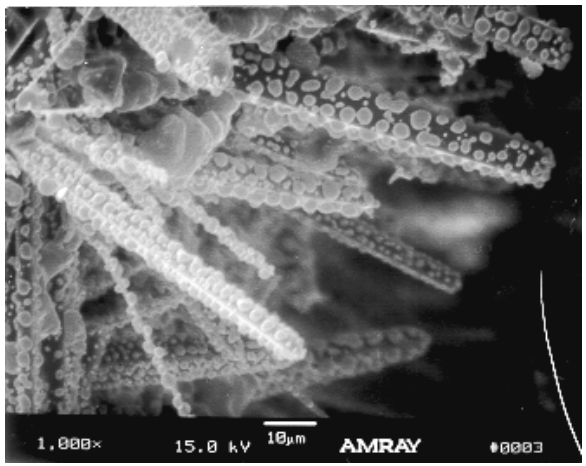




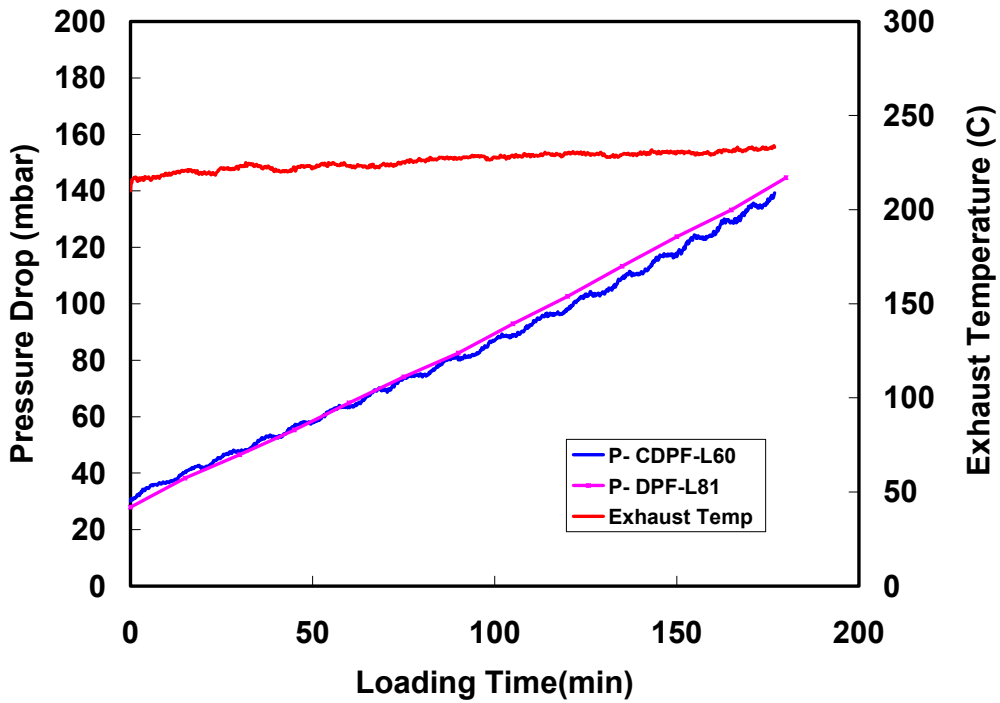
Coating Catalyst on ACM



Uniform catalyst costing and evenly dispersed throughout the substrate.

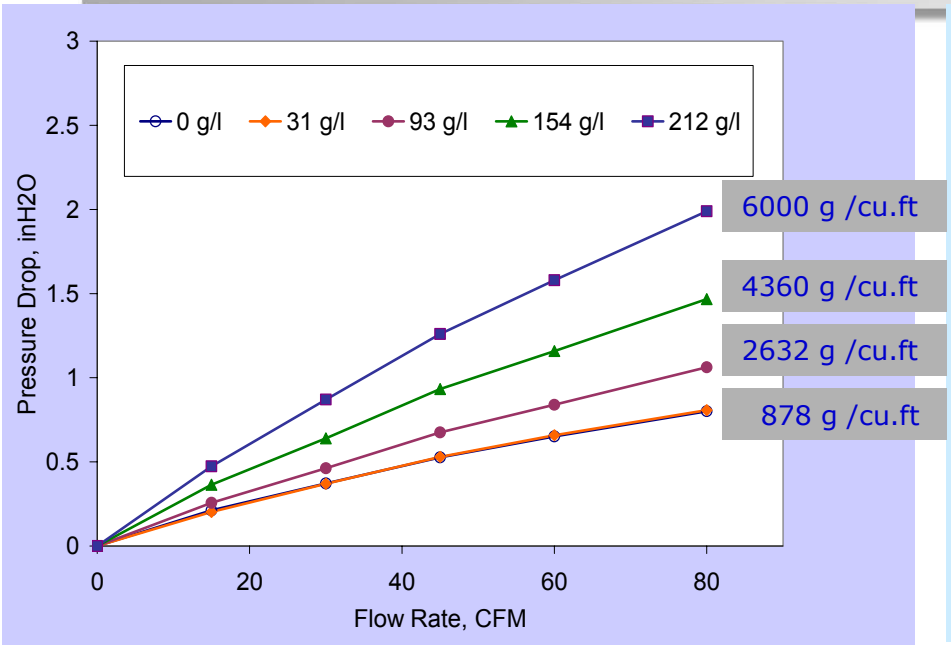


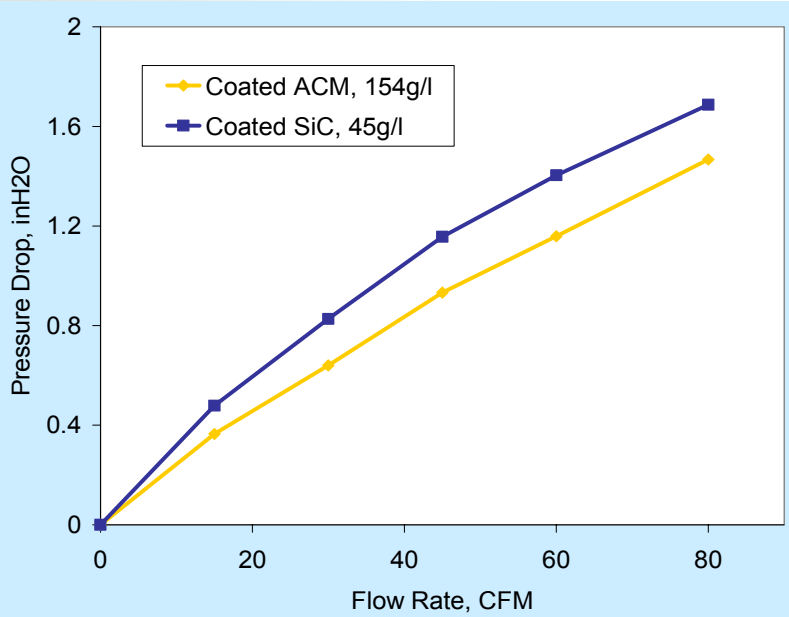
Adhesion of catalyst coating is being characterized.

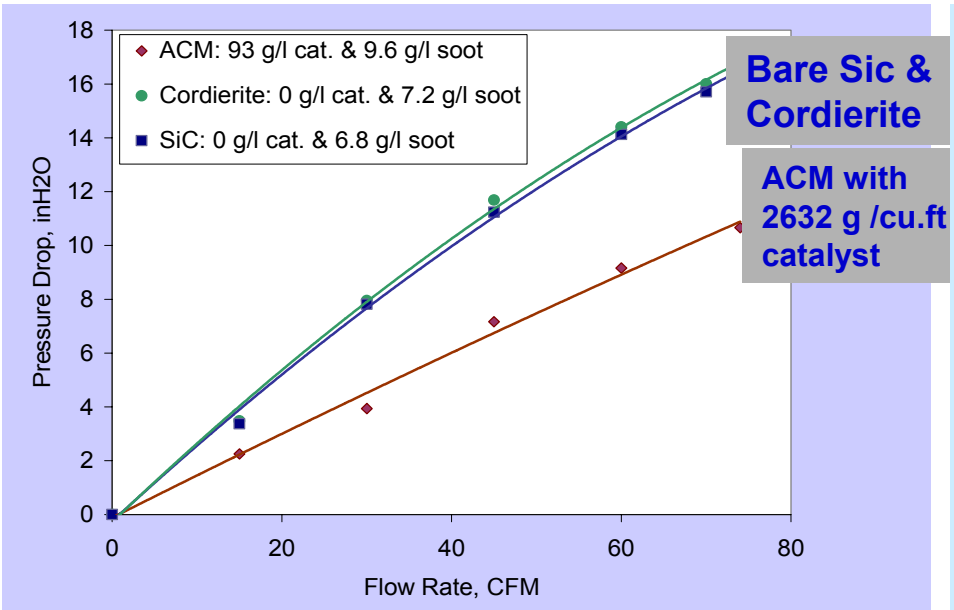


No observed pressure drop increase when 700 g/ft3 catalyst has been coated on ACM DPF

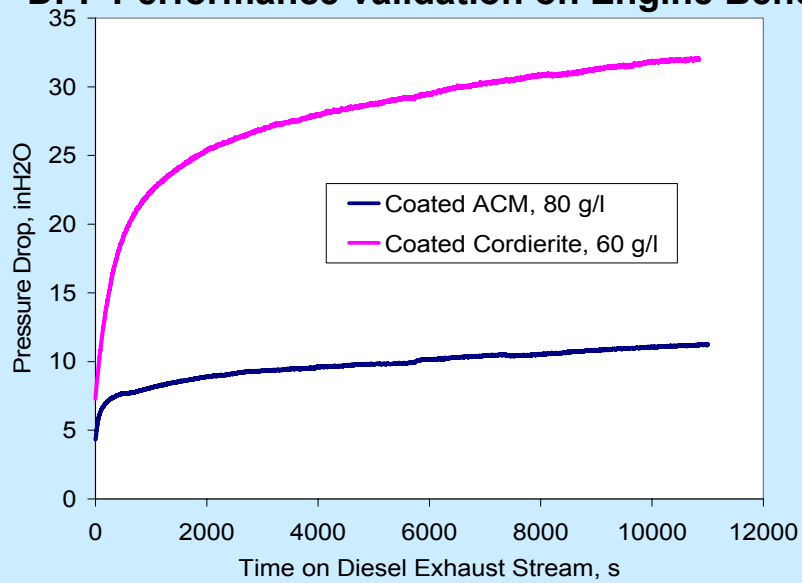
High Catalyst Loading Capacity and Performance







DPF Performance validation on Engine Bench



Preliminary Study of Nano Particles Filtration

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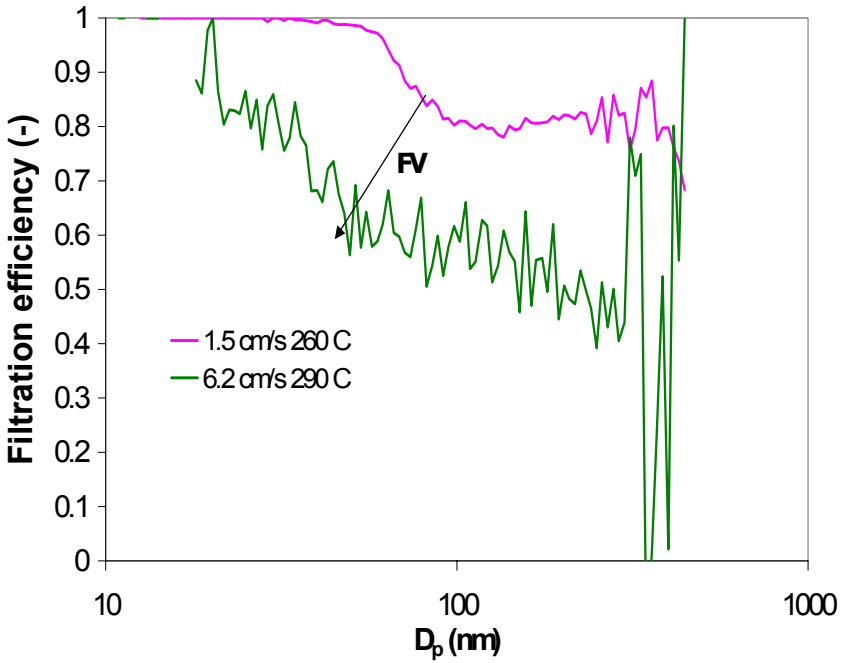
Measurement Method used in this study

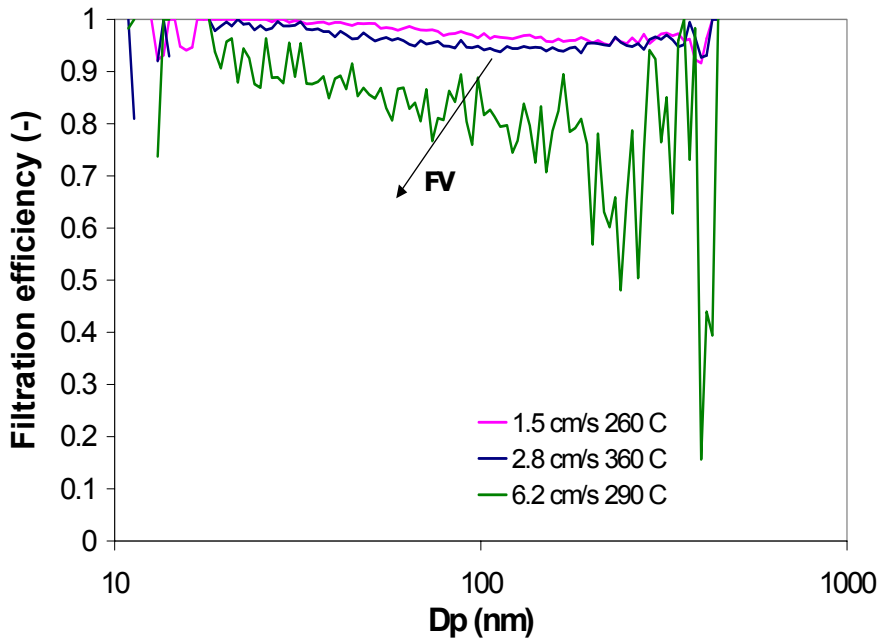
- **Electric Low Pressure Impactor (ELPI).**
  - ***particle number concentration of particles with size in the range of 30 nm to 8 μm.***
- **Condensation Particle Counter (Standalone CPC).**
  - ***real-time total number particle concentration measurements.***
- **Scanning Mobility Particle Sizer (SMPS).**
  - ***the number concentration of each particle size in the range of 10 to 430 nm.***
  - ***measure continuously (real time) number particle concentration at a given particle size (e.g. 80 nm).***
- **Nanoparticle Metrology system (NANOMET)**
  - ***The DC (Diffusion Charger) sensor provides the total accessible surface of the diesel aerosol (μm2/cm3).***
  - ***The PAS (Photoelectric Aerosol Sensor) provides a signal (in fA) that correlates with the particles' elemental carbon content.***

Performance of Nano Size Particulate Filtration

- Most of filtration with pile-of-stones styles are interception or collusion interruption due to the surface structure
- ACM morphology enable both interception and Brown force diffusion to capture particles

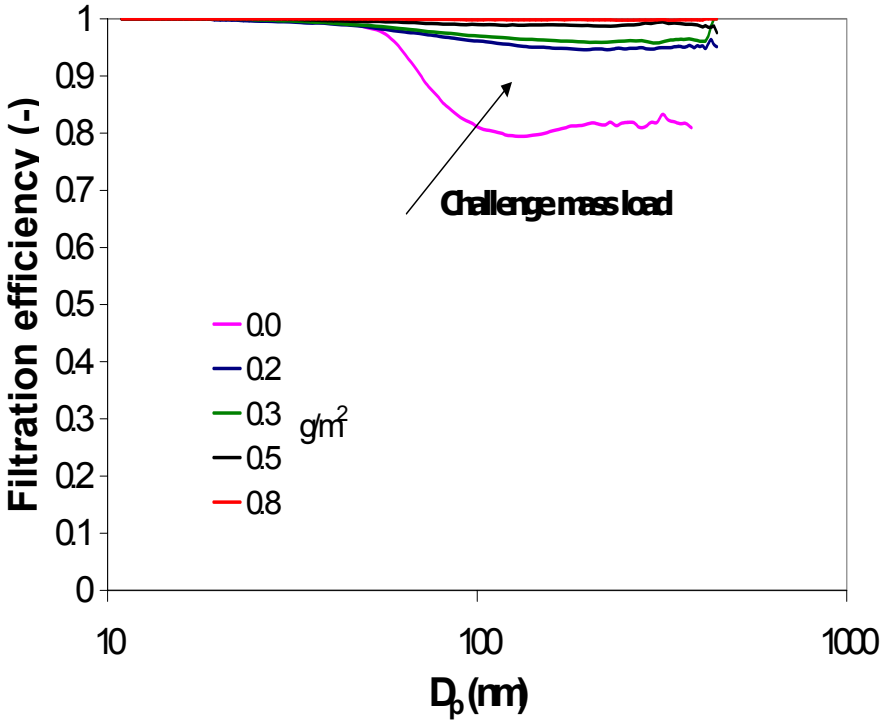


Effect of FV on SMPS measured size specific FE at 0 gr/m2 challenge mass load (clean filter)

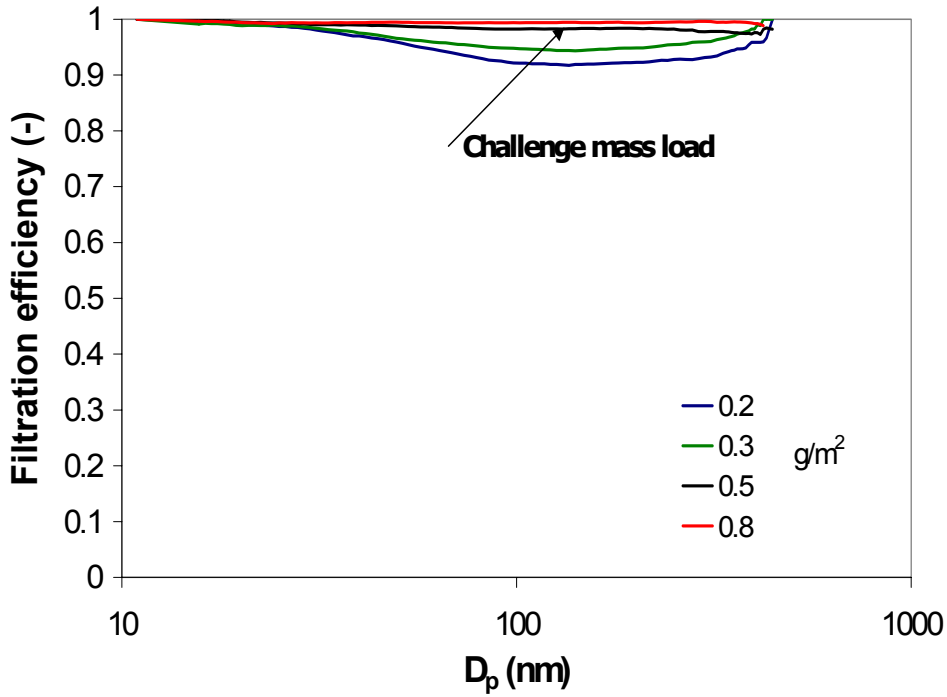


Effect of FV on SMPS measured size specific FE at 0.3 gr/m2 challenge mass load

Linear velocity Impact on Filtration

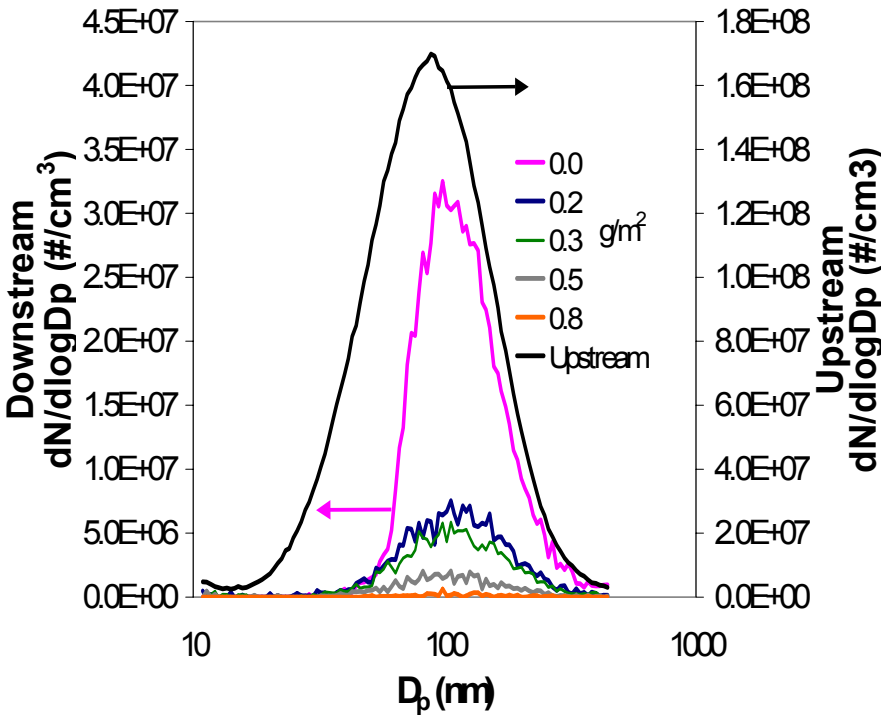


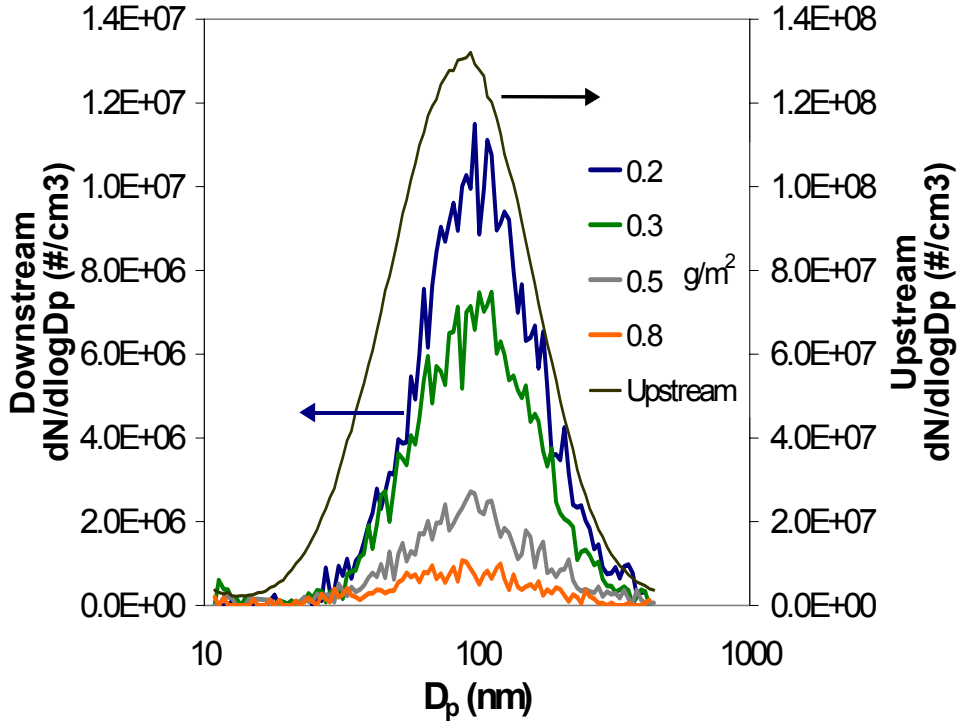
Effect of challenge mass load on size-specific FE at FV of 1.5 cm/s



Effect of challenge mass load on size-specific FE at FV of 2.8 cm/s

Overall Filtration Efficiency





Particle size distributions across DPF during soot loading at FV of 1.5 cm/s

Particle size distributions across DPF during soot loading at FV of 2.8 cm/s

ACM DPF Performance Summary

- ACM DPF has superior chemical resistance to ash and metal oxides
- Engine tests with ACM DPF's have demonstrated:
  - High filtration efficiency
  - 30% less back pressure compared to SiC
  - Faster regeneration compared to SiC
- Catalyst can be coated on ACM DPF substrate
- Coated ACM DPF maintains lower back pressure performance even with 3 times more catalyst loading in comparing to SiC
- The unique microstructure of ACM DPF enable the application 4-way emission control systems

Summary of Nano Particle Study

- ACM filtration study demonstrated that the needle crystal structure enable to capture particles with both interception and Brown diffusion force
- ACM DPF has high filtration efficiency to capture nano particles - especially under 100 nano meter
- Date from full size (5.66x6) ACM DPF test demonstrates >80% filtration efficiency for particle size from 20-1000 nano meter

Application Example

Acknowledgement

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