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XP-SiC: An Innovative Substrate for Future Applications with Low Weight and High Porosity

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Motivation

- To develop a substrate with high porosity, low weight and low cost to fulfill the requirements and challenges for current and future soot emission legislations

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Outline

- Introduction of XP-SiC
- Experiments
  - Cambustion DPG
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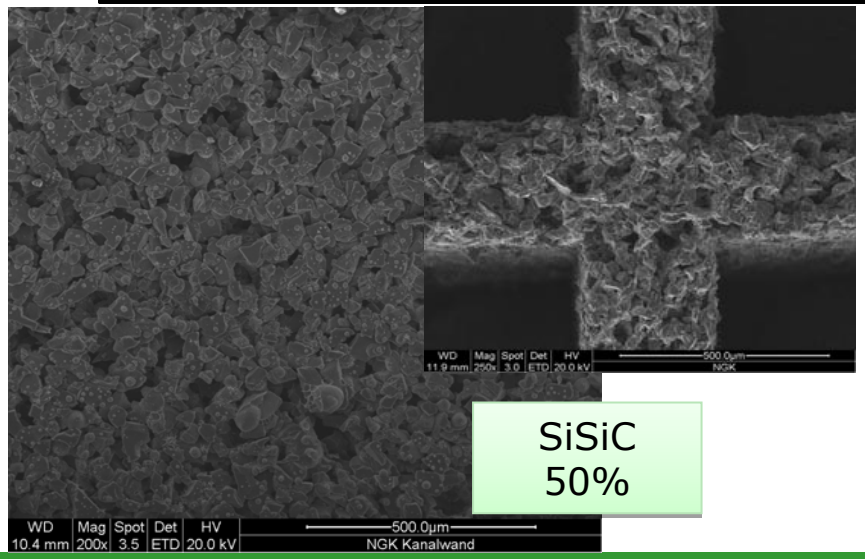
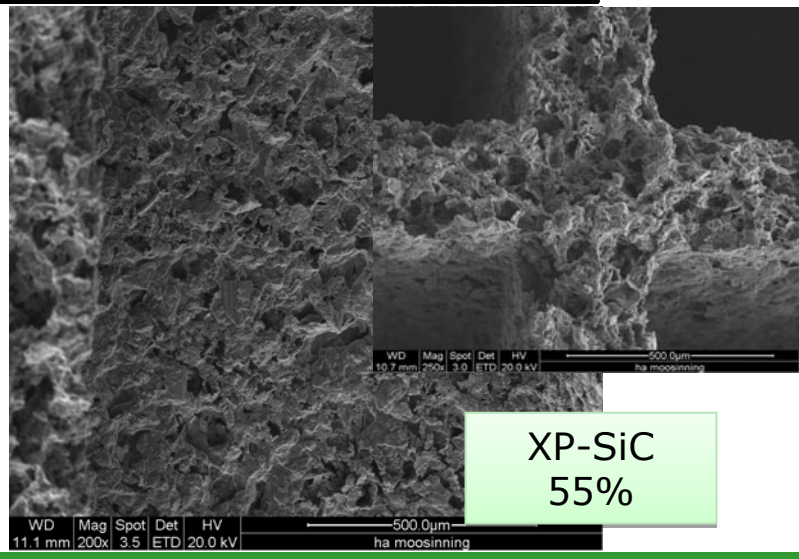
XP-SiC* an Alternative to SiSiC, lps-SiC, and R-SiC

Material	Raw material	Process & temperature
R-SiC	SiC bimodal	Recrystallization, >2000°C
lps-SiC	SiC, flux material	Sintering @ 1900°C
SiSiC	Si, SiC	Sintering @ 1500°C
XP-SiC*	Si, C	Reaction forming @ 1450°C



SiSiC
50%



XP-SiC
55%

* Patent pending EP 1741687 A1, EP 1741685 A1, US20070032370, WO2007/003428A1

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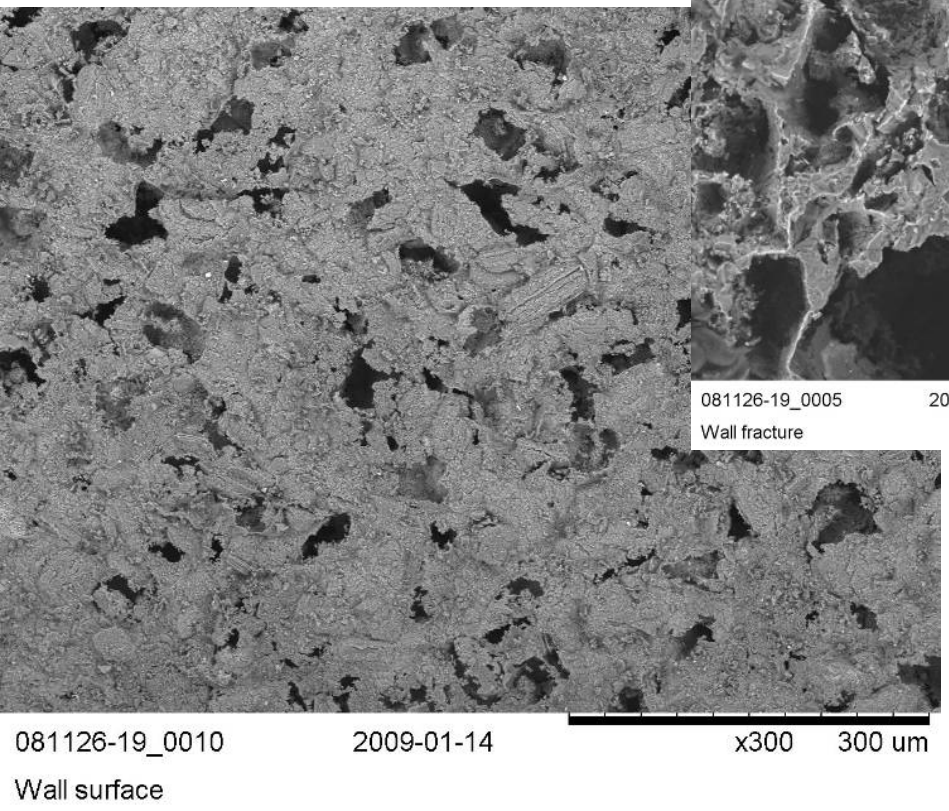
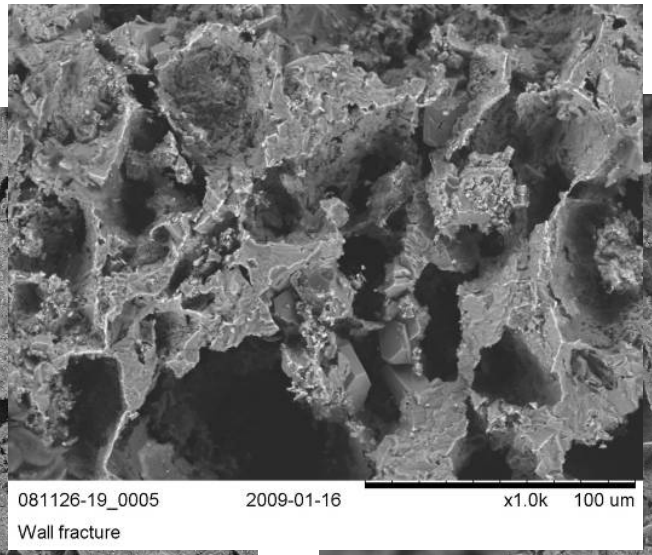
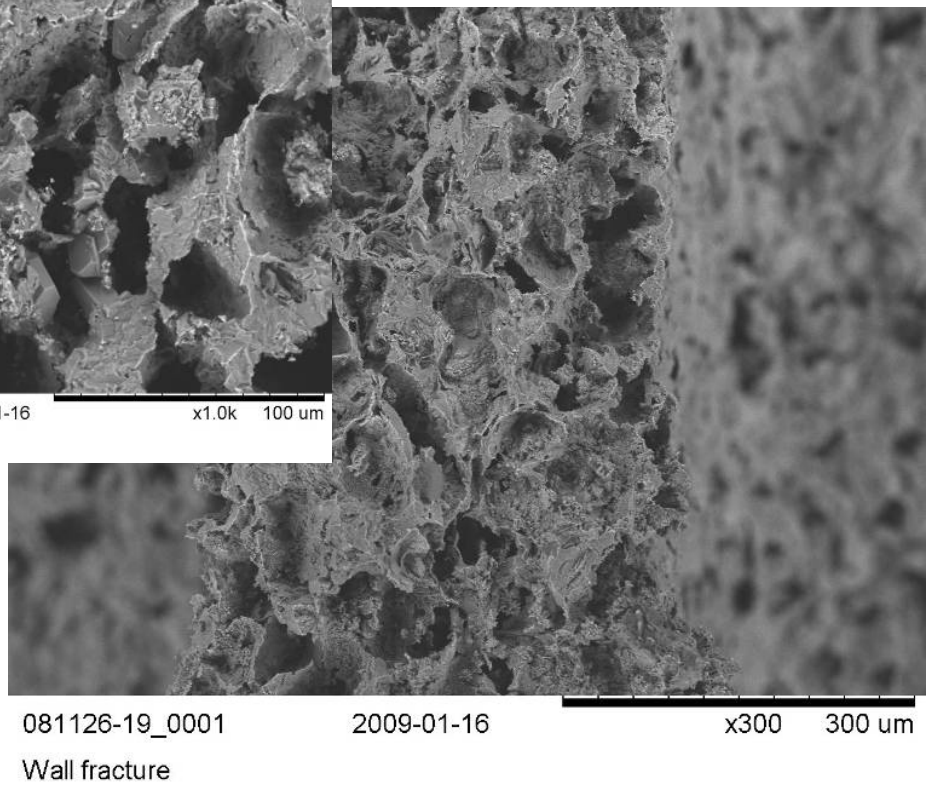
Pore Structure with a Small Pore Size

13µm, 58%, 560g/l







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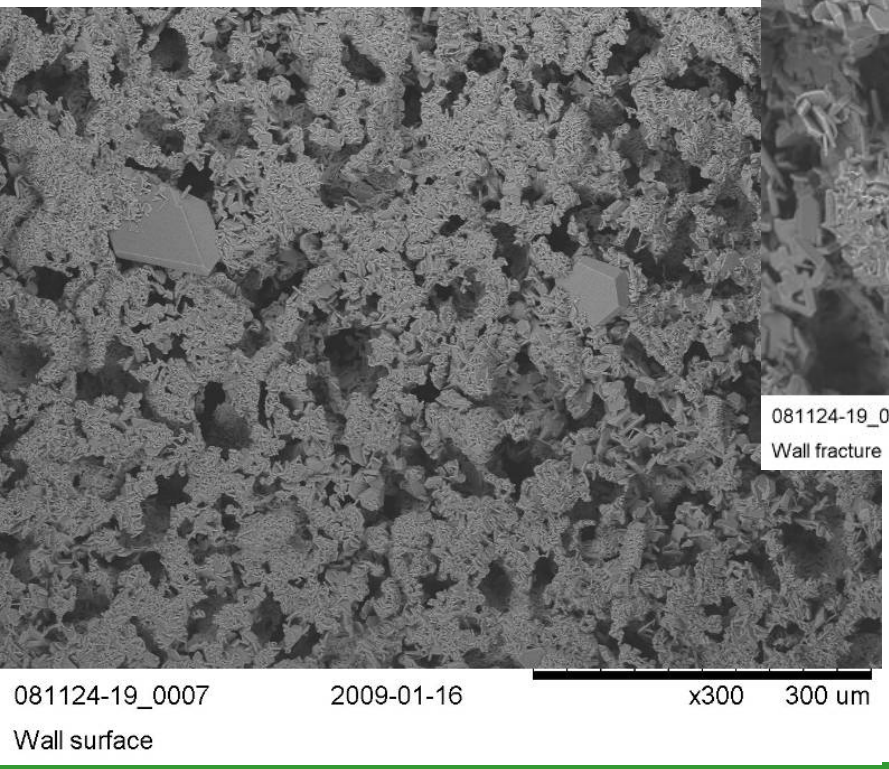
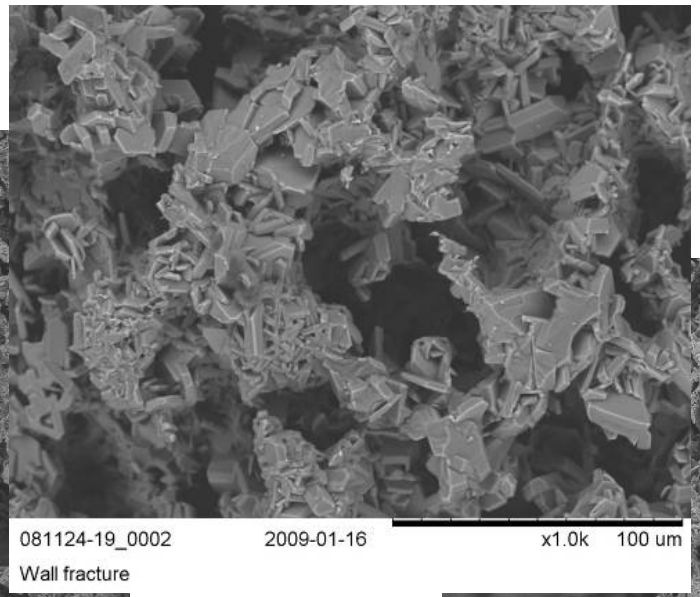
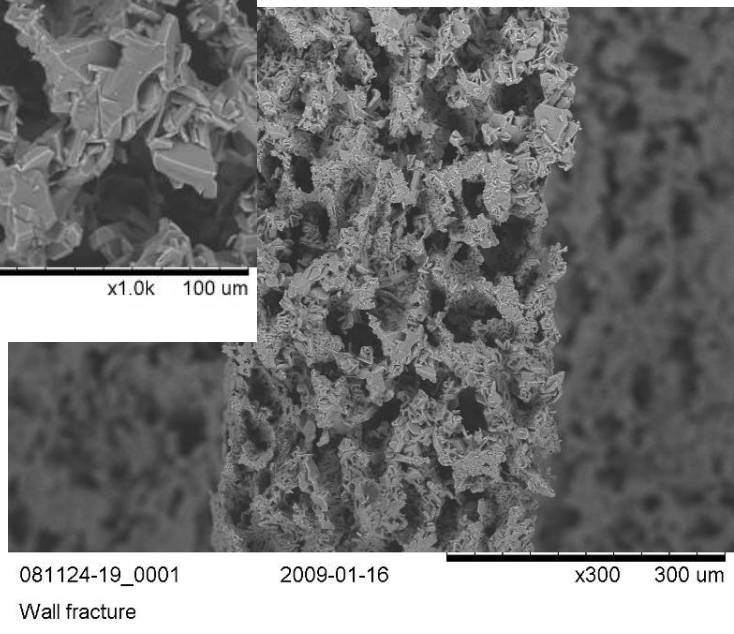
Pore Structure with Large Pore Size for High Wash-coat Loadings

22µm, 62%, 520g/l







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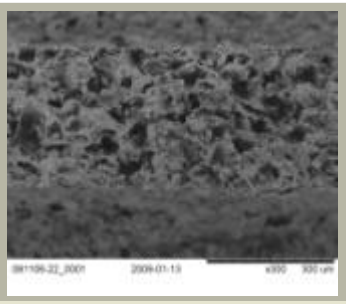
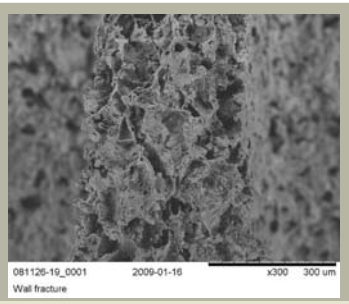
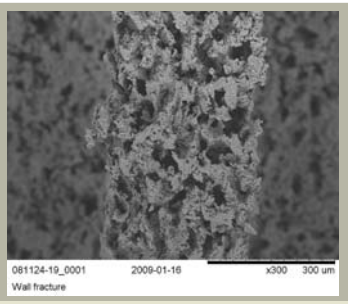
XP Substrate Variants

	XP200	XP300	XP300	XP300
				
Cell density	200	300	300	300
Wall thickness	16 mil	12 mil	12 mil	12 mil
Porosity	~55%	~55%	58 – 60%	60 – 62%
Pore diameter	11 – 15µm	11 – 15µm	13 – 18µm	20 - 22µm
Substrate weight	620 g/l	580 g/l	540 - 560 g/l	520 - 540 g/l
Soot mass limit	> 10 gl	10g/l	9 g/l	8 g/l

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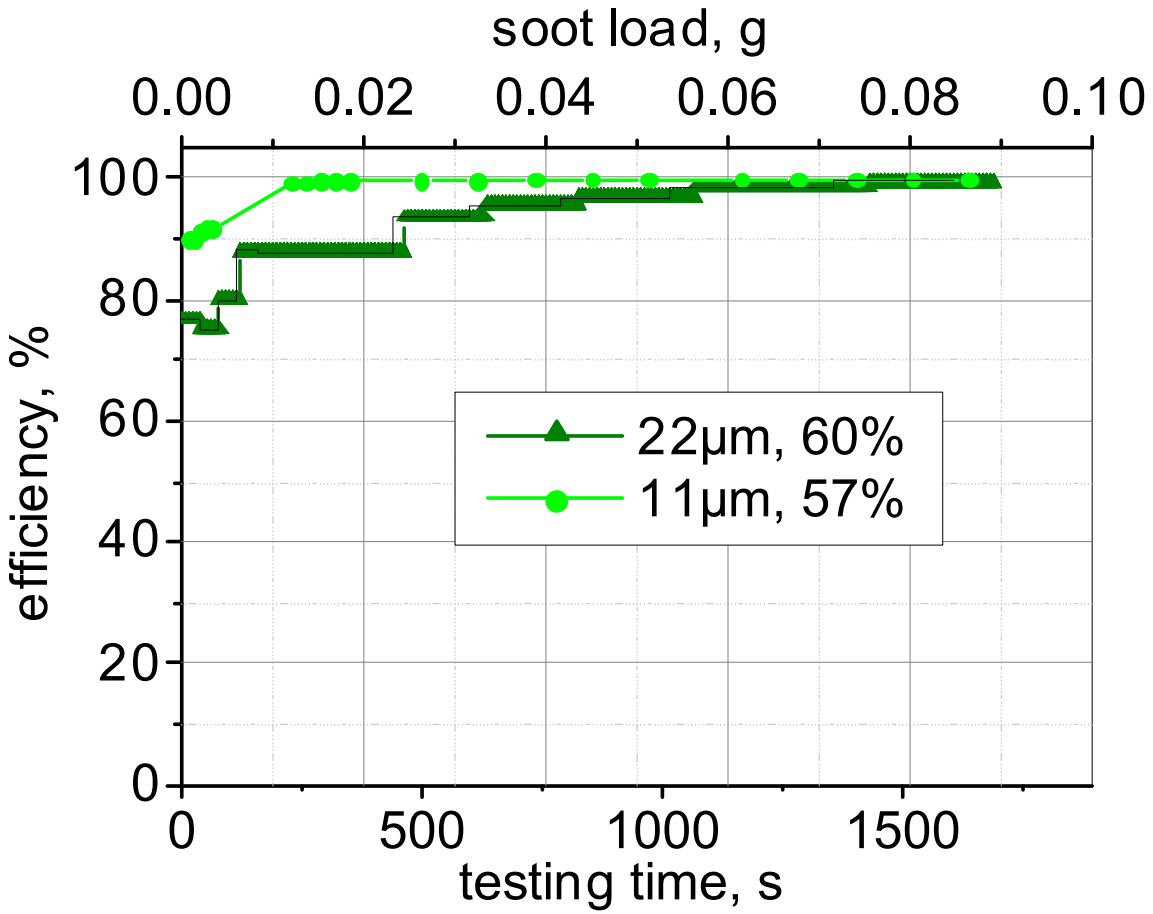
Filtration Efficiency

- **Cambustion standard DPG system**
- **Generating of soot particles by utilizing a diesel burner**
- **Generated soot particles represent an elemental/organic carbon ratio comparable to modern diesel engines**



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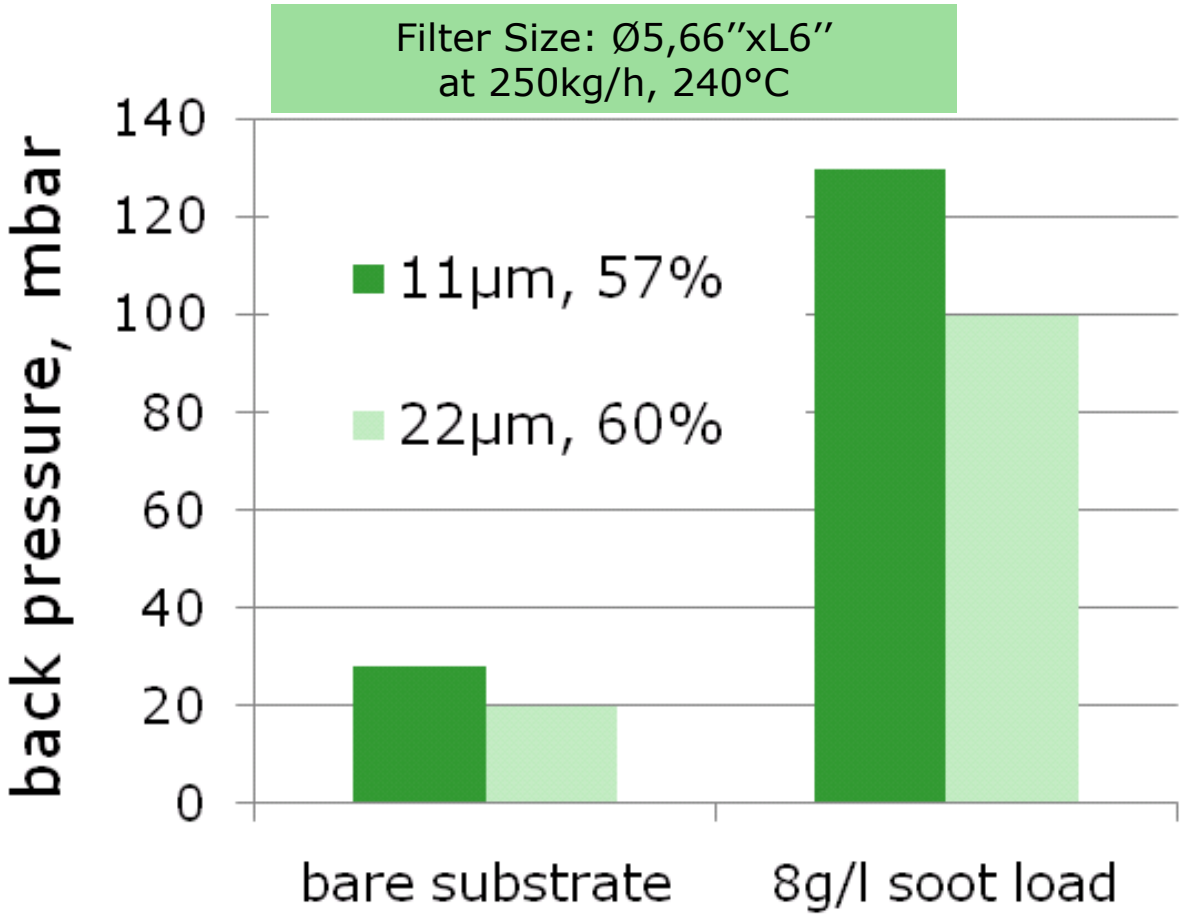
Back Pressure



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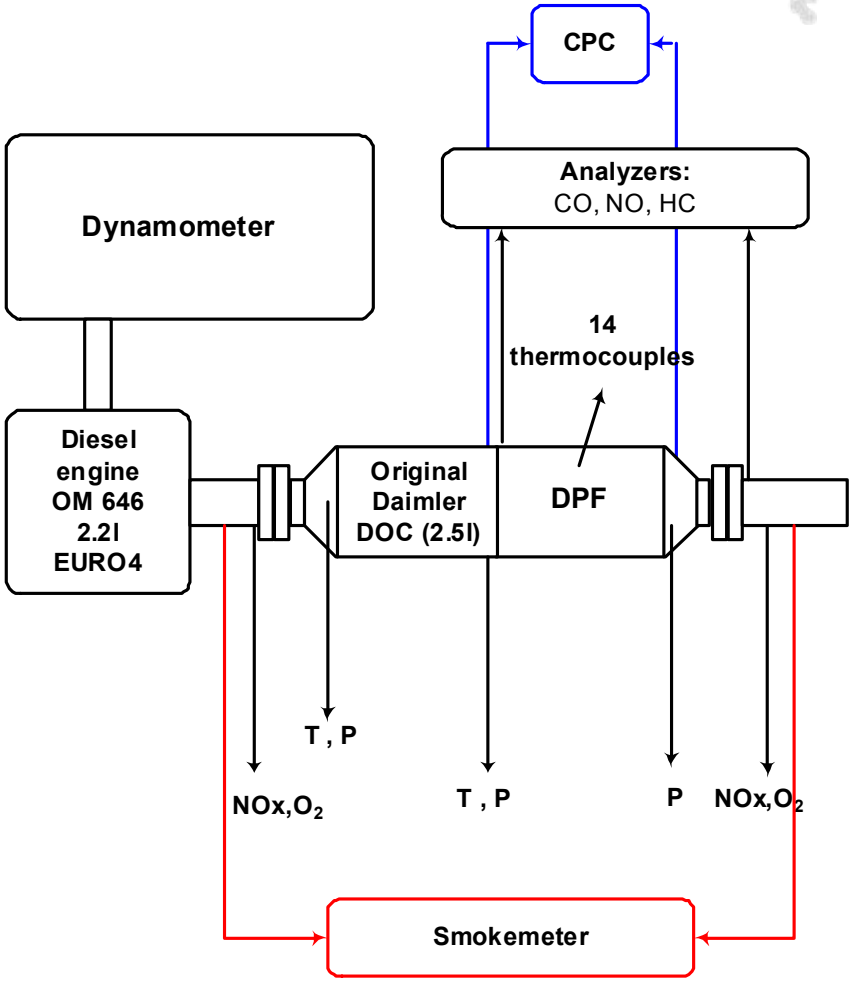
Test Setup



T: Temperature
P: Pressure

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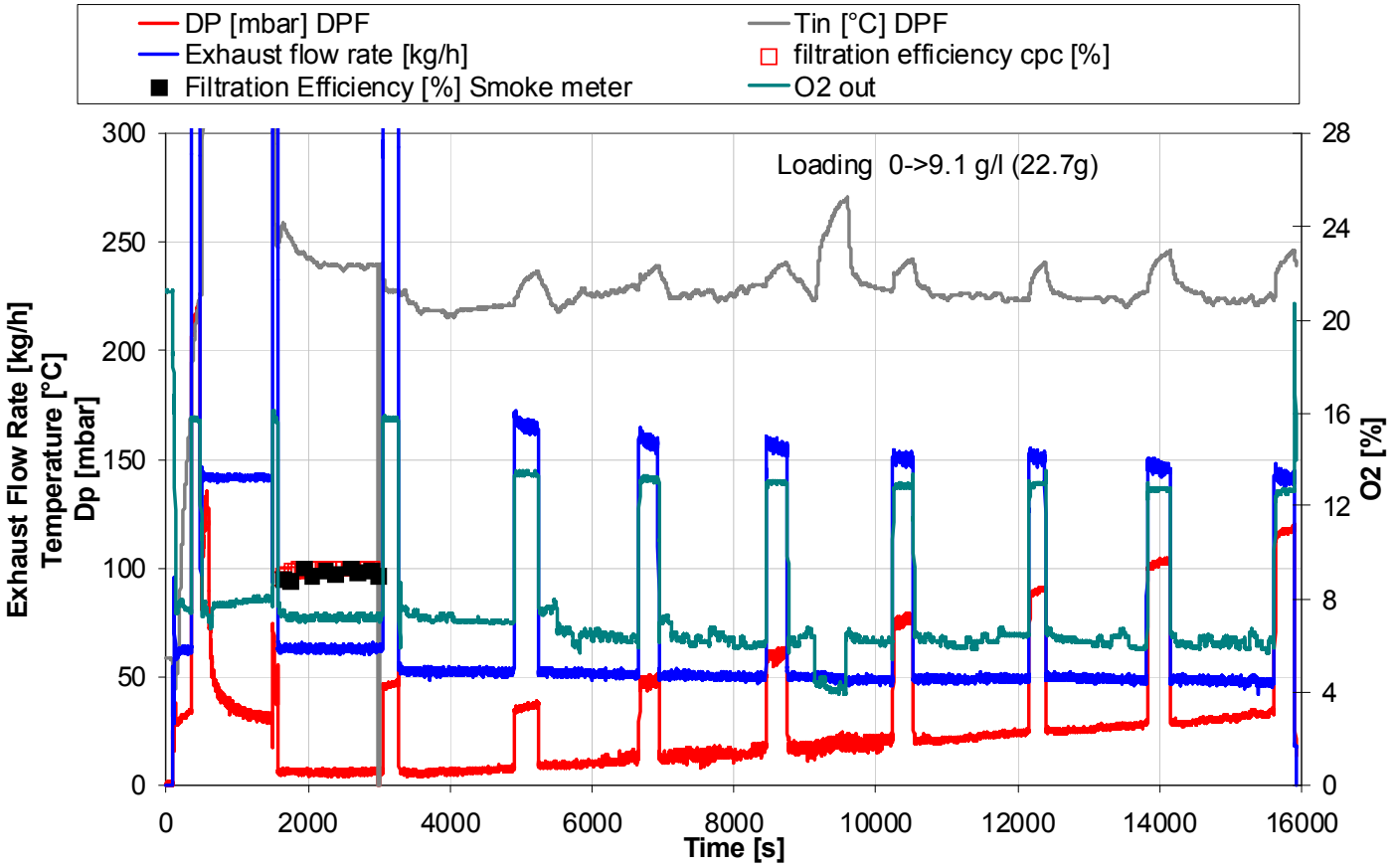
Engine Bench Data: Soot Loading and Filtration Efficiency



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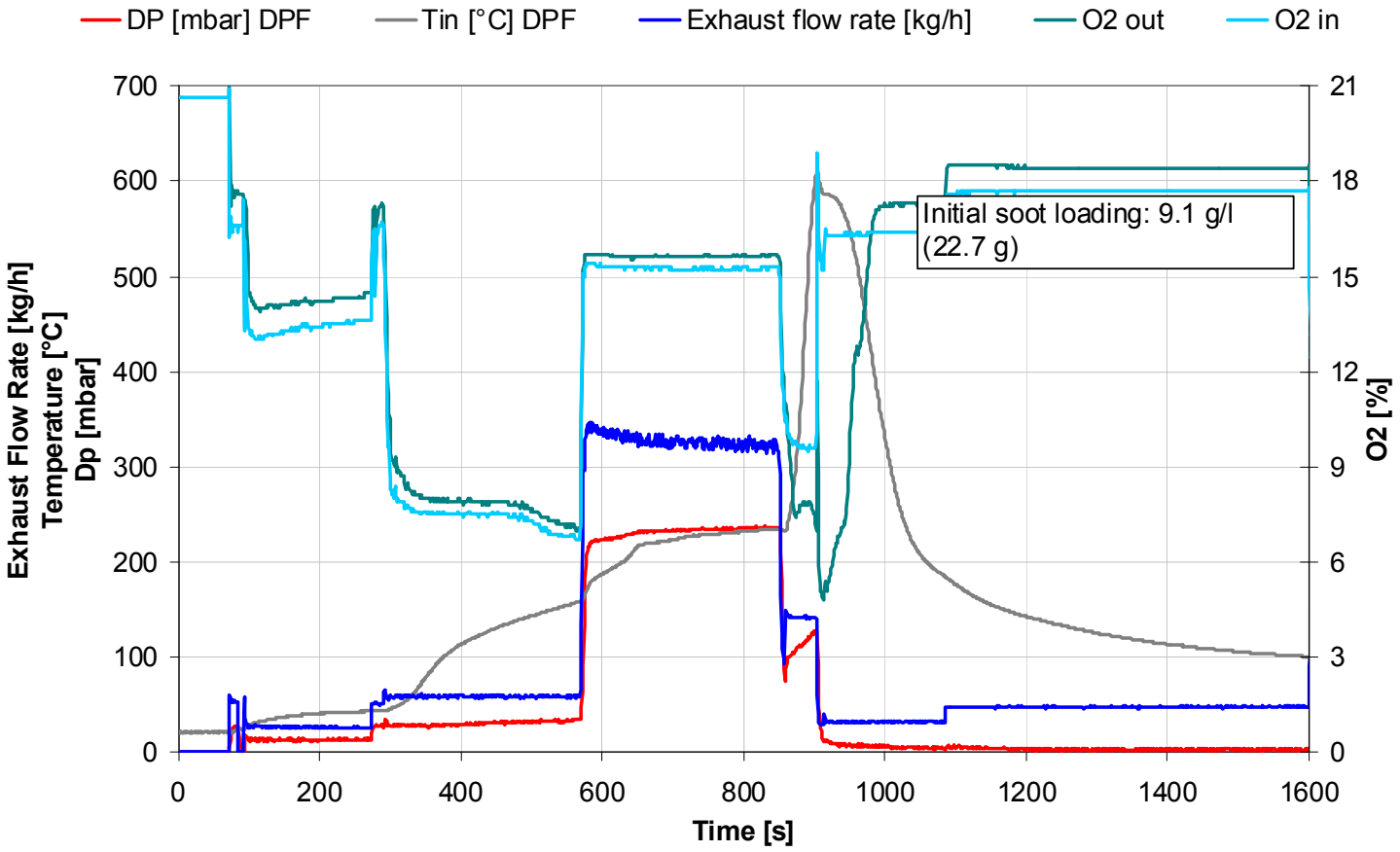
Engine Bench Data: DTI, FBC Regeneration



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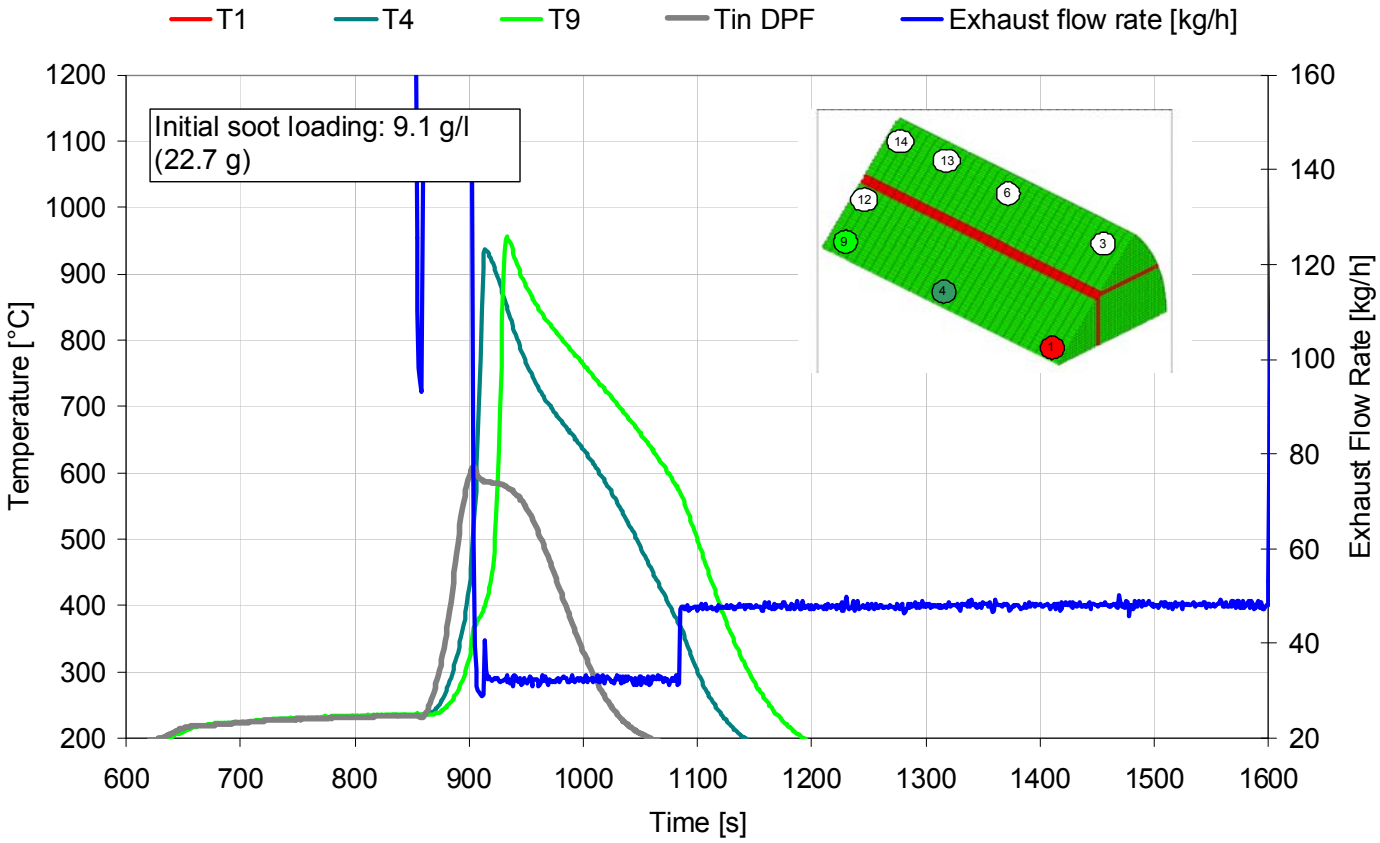
Engine Bench Data: DTI, Thermocouple Measurements (1)



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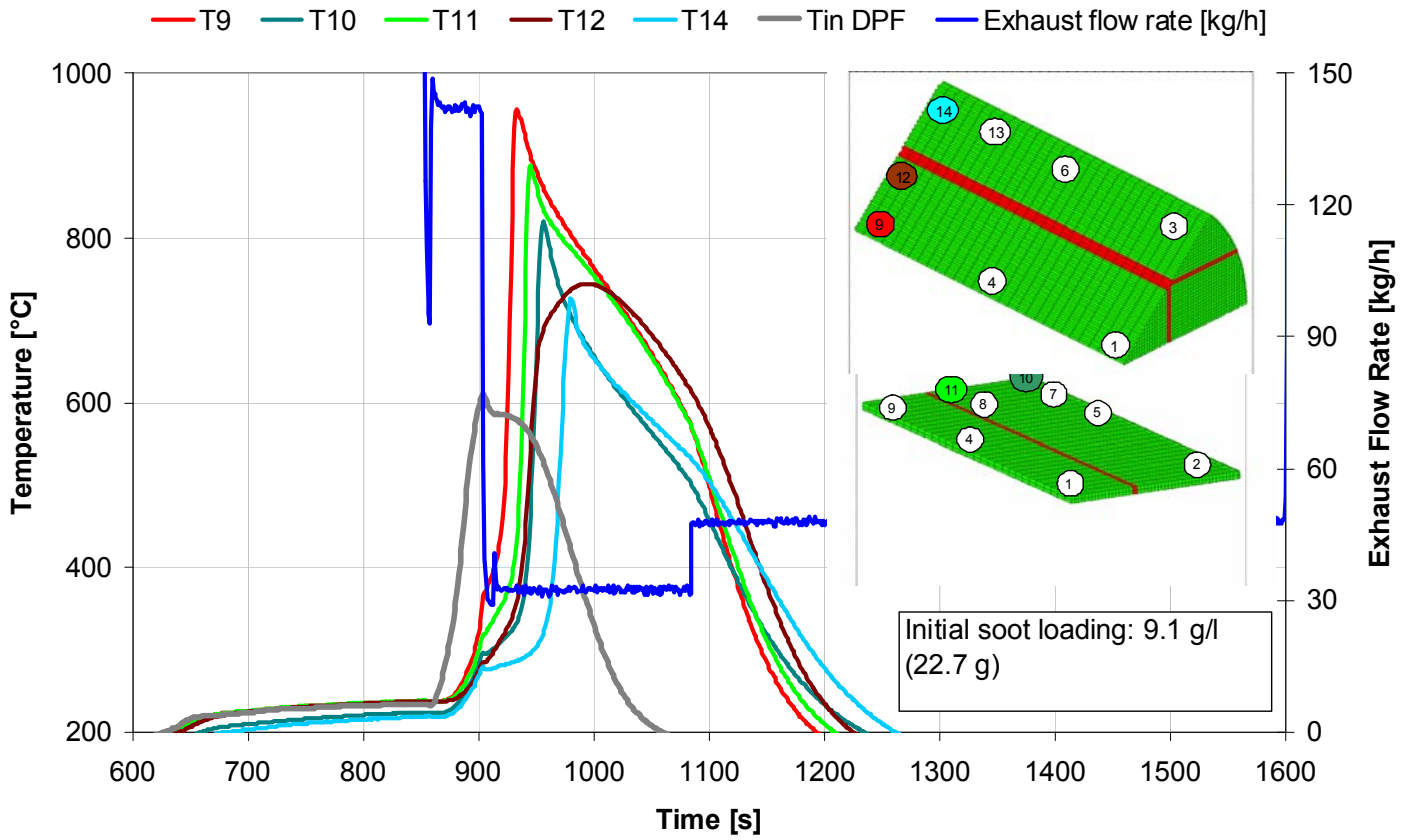
Engine Bench Data: DTI, Thermocouple Measurements (2)



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Simulations

- The commercial software module “axitrap” of axisuite™ from Exothermia was employed
- Detailed modeling of governing equations of mass, momentum, energy and species
- Calibration of wall and soot permeability based on the engine bench testing
- Calibration of chemical kinetic parameters for fuel-borne-catalyst based on the engine bench testing

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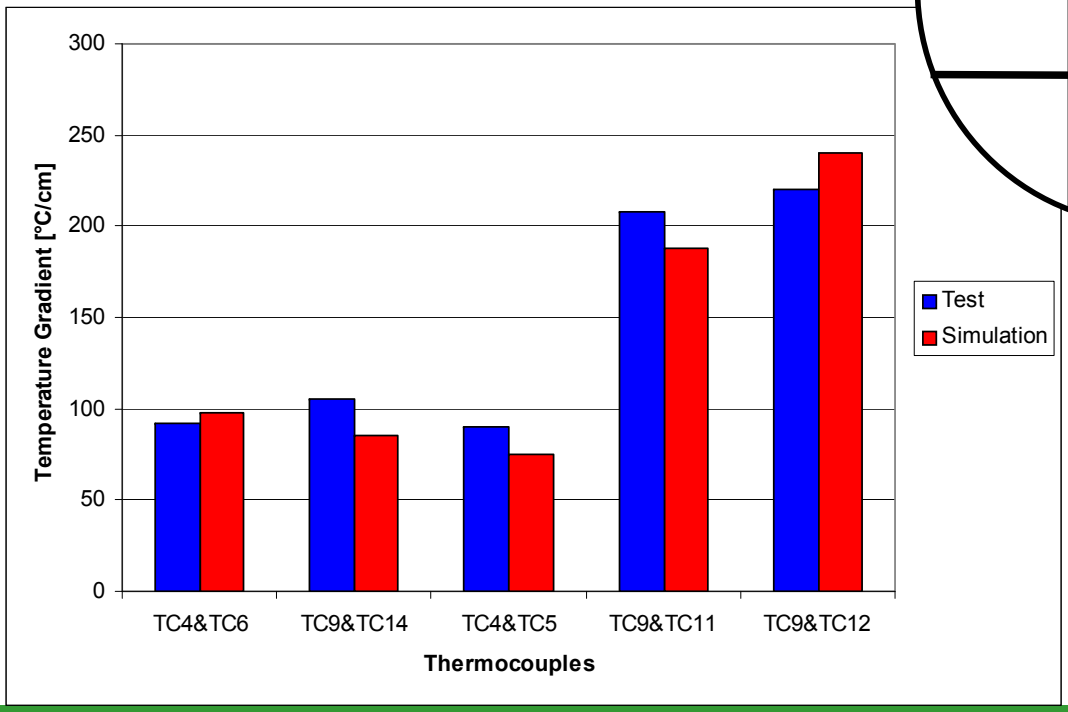
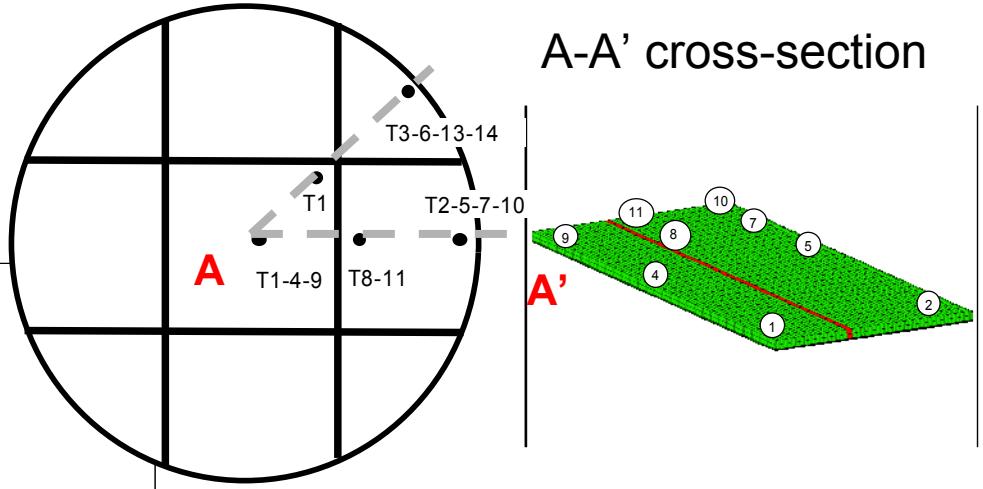
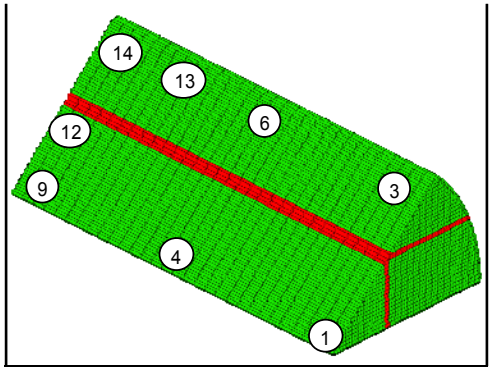
Radial Temperature Gradients

Initial Soot Load: 9.1 g/L







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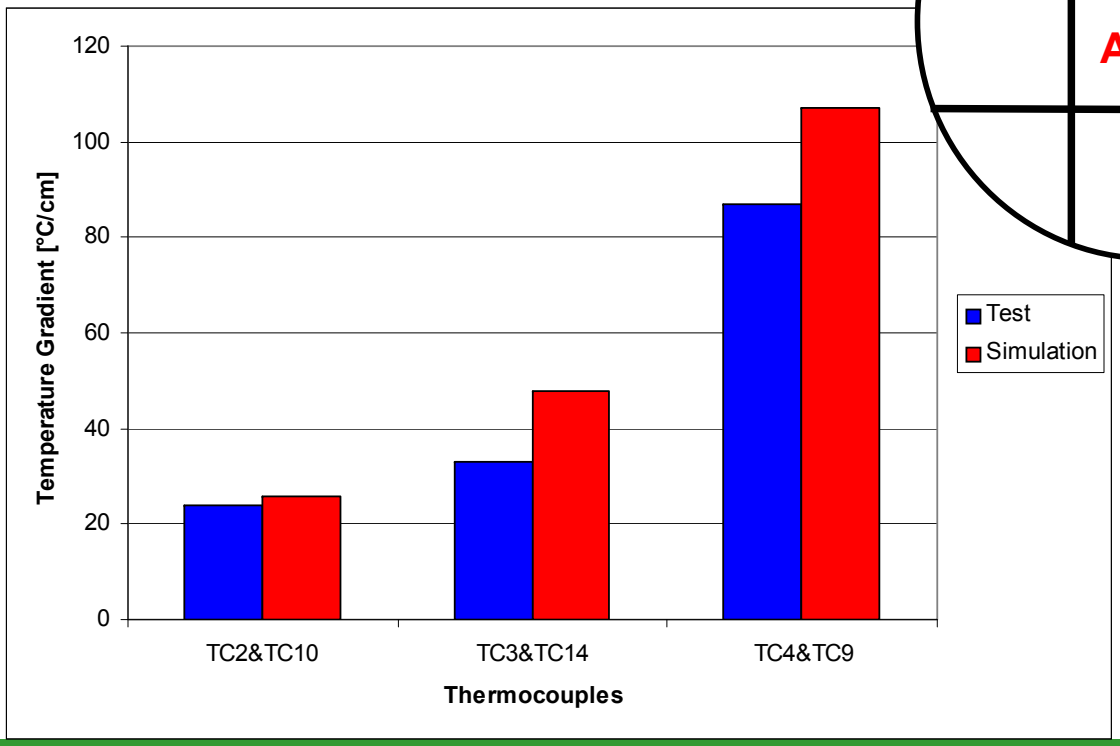
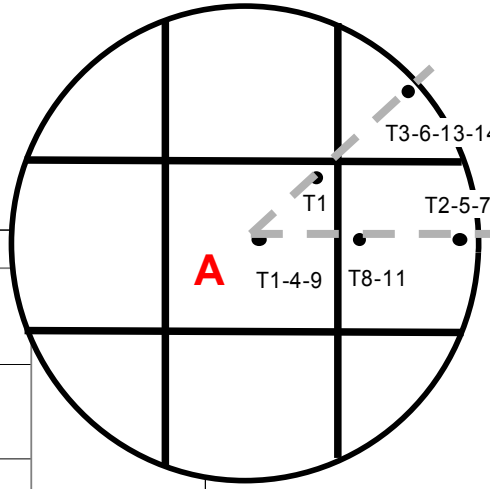
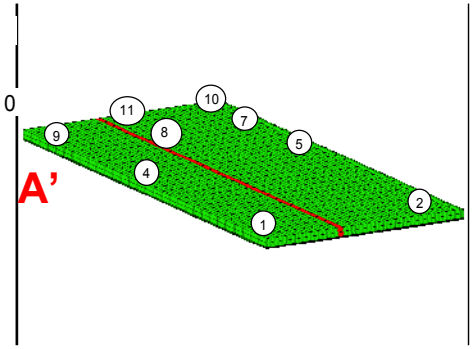
Axial Temperature Gradients

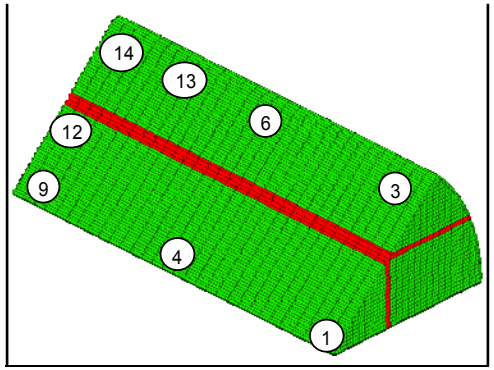
Initial Soot Load: 9.1 g/L





A-A' cross-section





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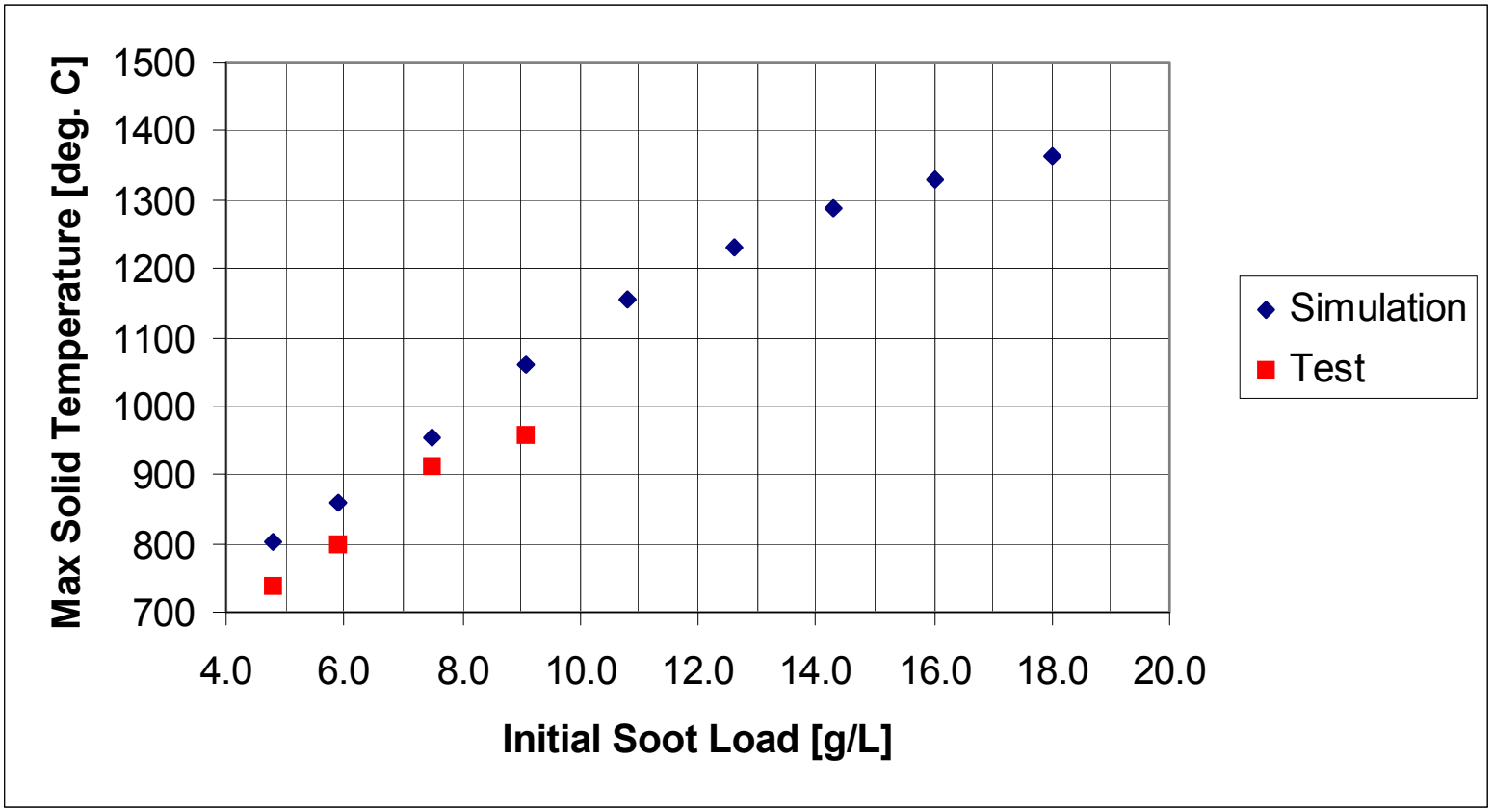
Maximal Temperature as a Function of Initial Soot Load



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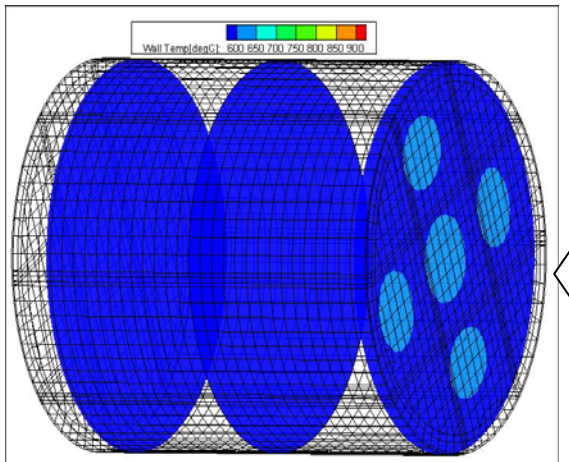
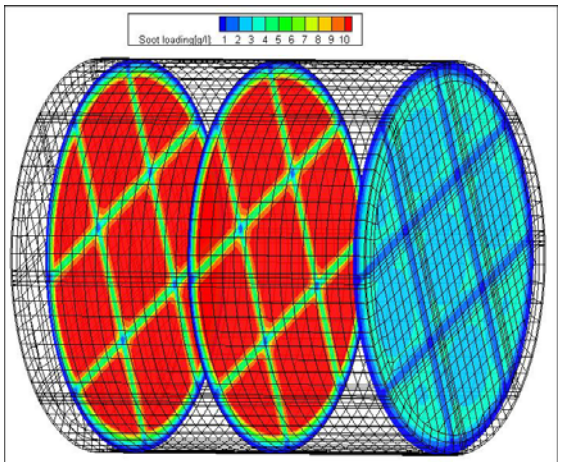
Radial Temperature and Soot Distribution during Regeneration (1)

Temperature

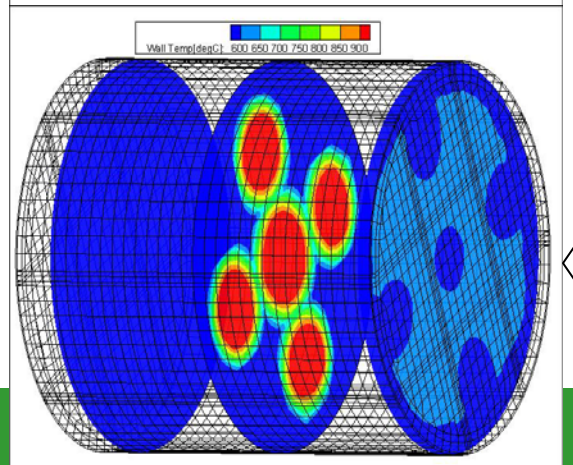
Soot

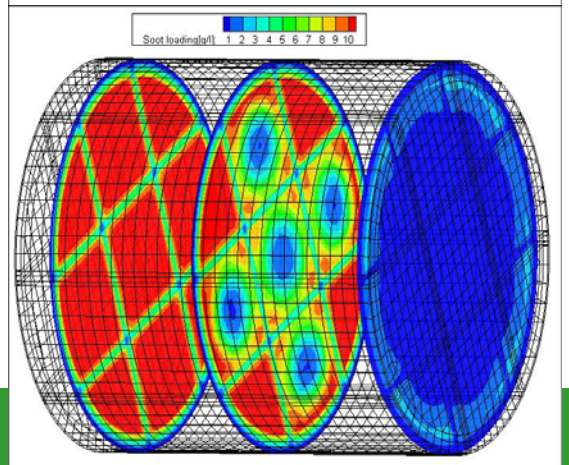
t = 410 s





t = 440 s





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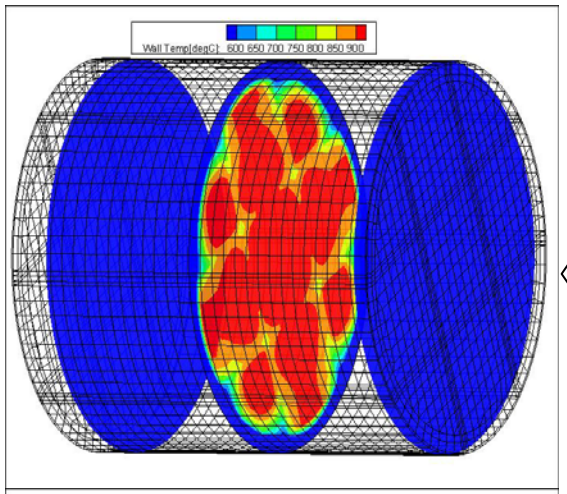
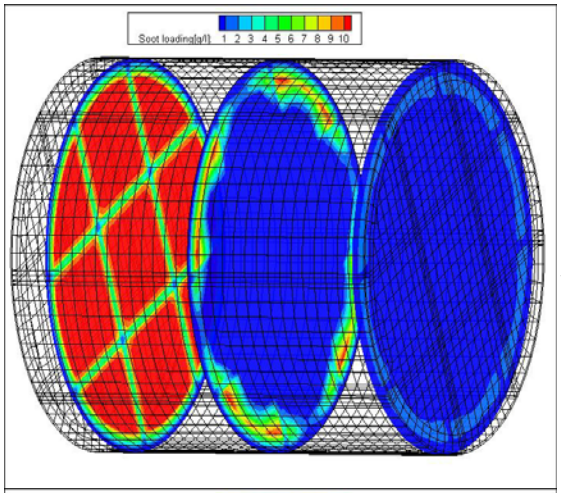
Radial Temperature and Soot Distribution during Regeneration (2)

Temperature

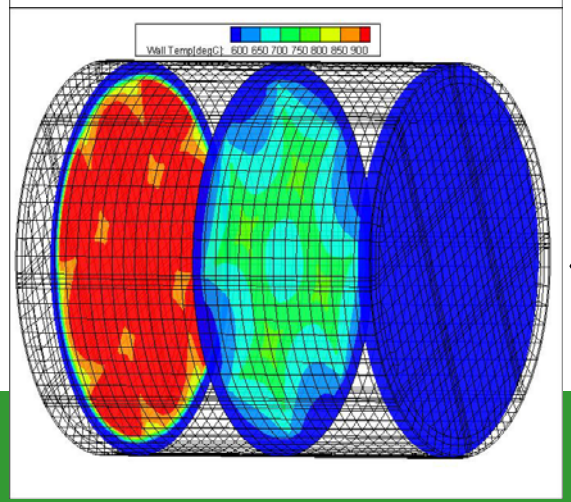
Soot

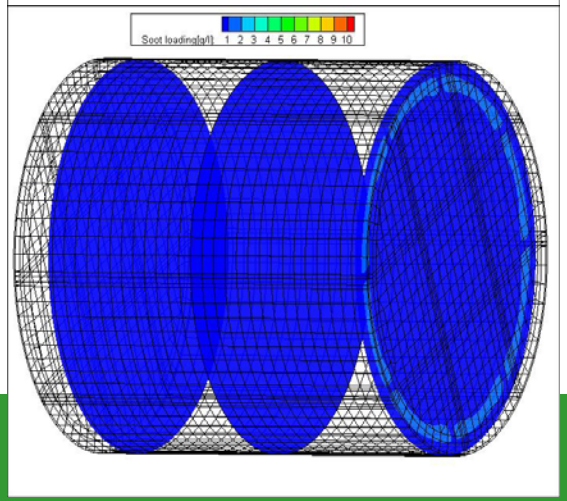
t = 460 s





t = 510 s





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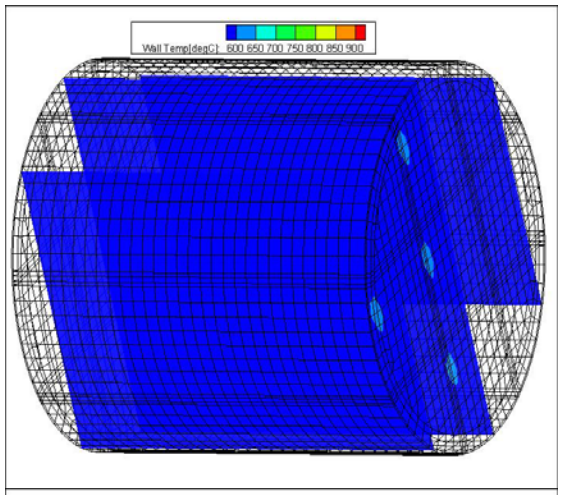
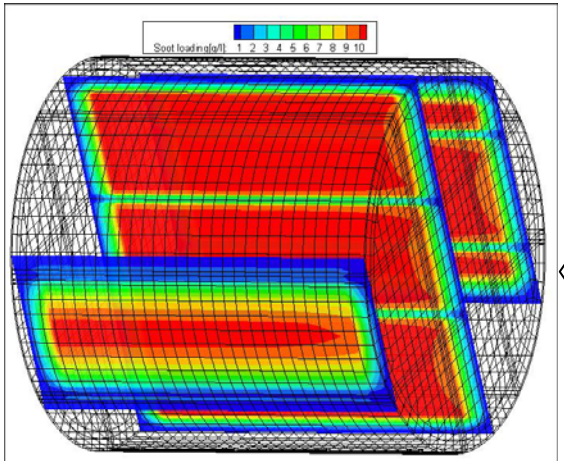
Axial Temperature and Soot Distribution during Regeneration (1)

Temperature

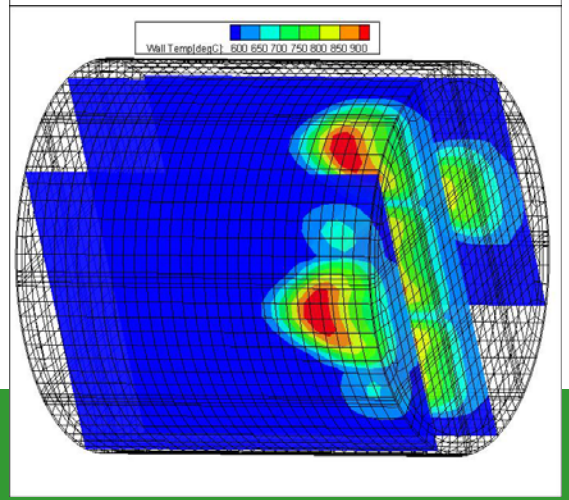
Soot

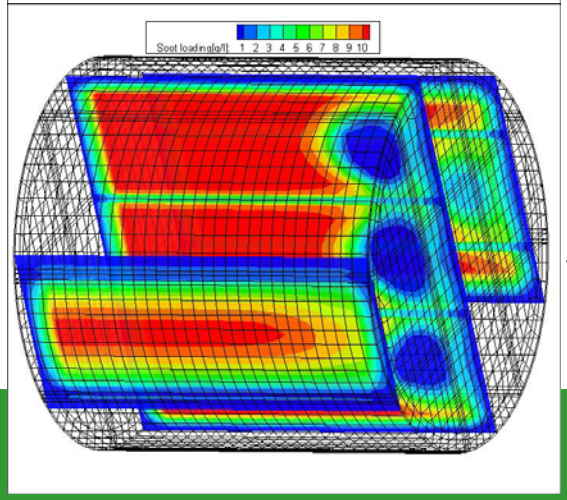
t = 400 s





t = 420 s





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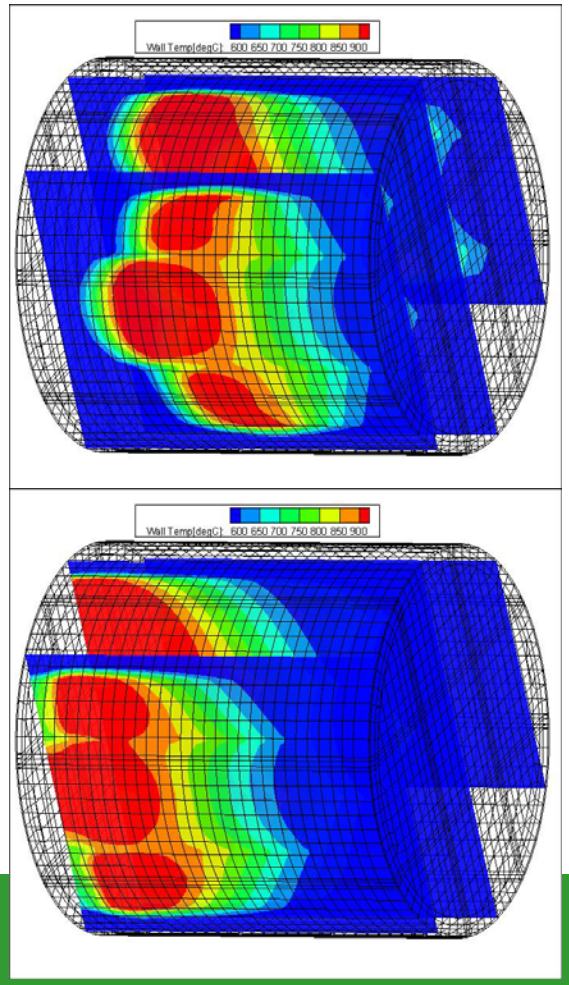
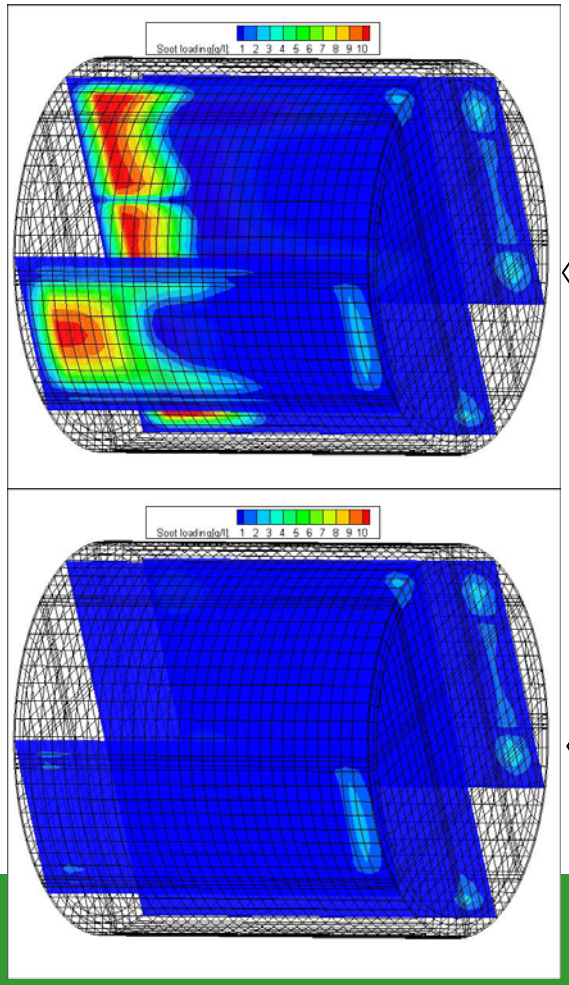
Axial Temperature and Soot Distribution during Regeneration (2)

Temperature

Soot





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Summary and Conclusions (1)

- XP-SiC can be developed with different range of porosity and pore size levels
- In addition XP-SiC substrate can be tailored with different cell structures
- Low specific weight is one of special features of XP-SiC substrate
- Possibility of high porosity and large pore size make this substrate appropriate for high levels of wash-coats

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Summary and Conclusions (2)

- High filtration efficiency and low back pressure were observed both on engine bench and soot generator testing
- The measured temperature gradients were correlated with the simulated ones
- Considering low weight, the substrate represents a “good” thermal behavior and thereby an “acceptable” range of soot mass limit

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Thank you for your attention!