High filtration DPF substrate development for upcoming emission norm BSVII

P20241023-ECMA

Emission regulation trend

- In European market, emission authority is requesting tighter emission norms from EUVI to EUVII.
- Regarding the particle number: PN emission, the scope of particle size is expanded from 23nm to 10nm.
- IBIDEN assumes similar emission norm will also be applied on India.

Table. Emission regulation trend

Category	Area	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
HD	EU	EU VI d/e -PN emission(PEMS/RDE)@23um -NOx emission@Cold									EU VII PN ; 10um	
	IND	BS VI phase1				BS VI phase2 -PN emission(RDE)@23um						BSVII?

Category	Area	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
NR	EU	Stage V -PN emission@23um -NOx emission@Cold										TBD?
	IND	TREM III -PM emission			TREM IV -NOx emission			TREM V -PN emission				

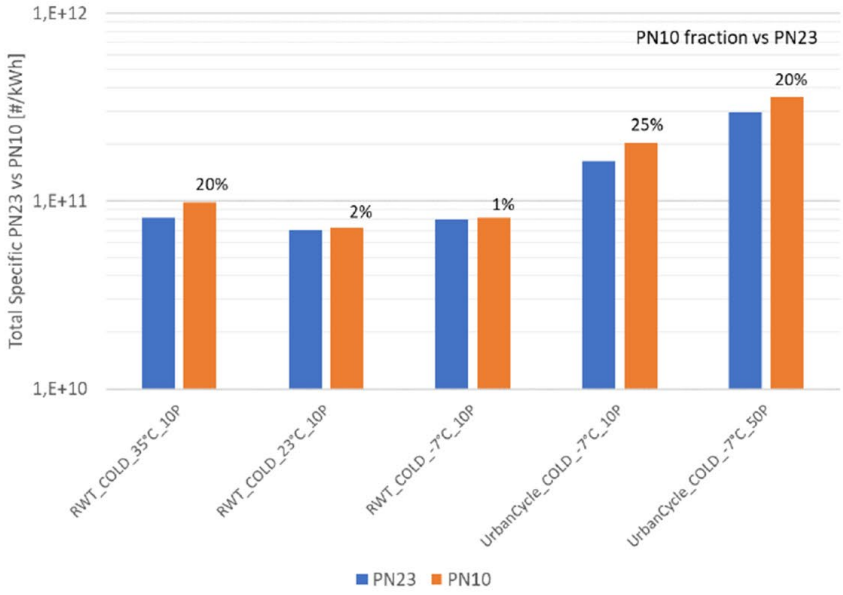
Impact to filtration performance (PN23 vs PN10)

- AECC reported PN test result with soot condition.
- According to AECC report, the difference b/w PN10 and PN23 is maximum 25%.

Ref. AECC report :Ultra-Low NOx Emissions with Close-Coupled Emission Control System on a Heavy-duty Truck Application (30th Aachen Colloquium Sustainable Mobility 2021 - 04-06 October 2021)

PN10 fraction in line with available literature

- PN10 measurement was conducted during the chassis dyno testing[1,2,4]
- Results show PN10 fraction varies from 1 to 25% vs PN23 which is in line with available literature[3]
- Tests are not covering all possible critical conditions for PN



RWT – Real World Test

[1] The results are reported as measured by the laboratory Particle number counter TSI 3772 used to measure PN10 under the specified test routes and conditions

[2] Tests were conducted with empty SCRs' ammonia storage and passively regenerated DPF unless indicated otherwise

[3] Giechaskiel et al. Environmental Research 197, June 2021, 111068

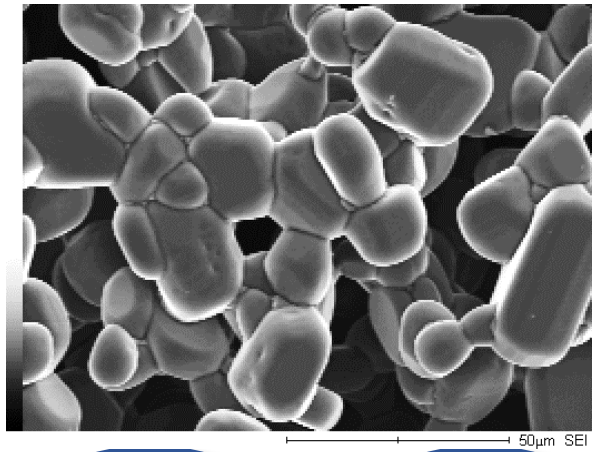
[4] PN10 results of the Urban non-conditioned cycle at -7°C are not included due to possible artifact measurement issue

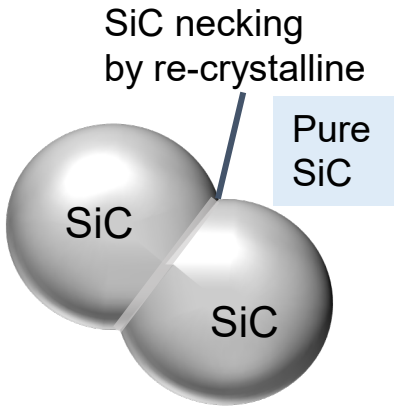
AECC ASSOCIATION FOR EMISSIONS CONTROL BY CATALYST

IBIDEN DPF : R-SiC characteristics

➢ IBIDEN product R-SiC DPF has sharp pore size distribution which leads to high filtration performance.

R-SiC character





High chemical resistance

High thermal conductivity

Sharp pore distribution

Contribution for DPF

Exhaust gas /ash resistance

Thermal resistance (Soot capacity)

Filtration

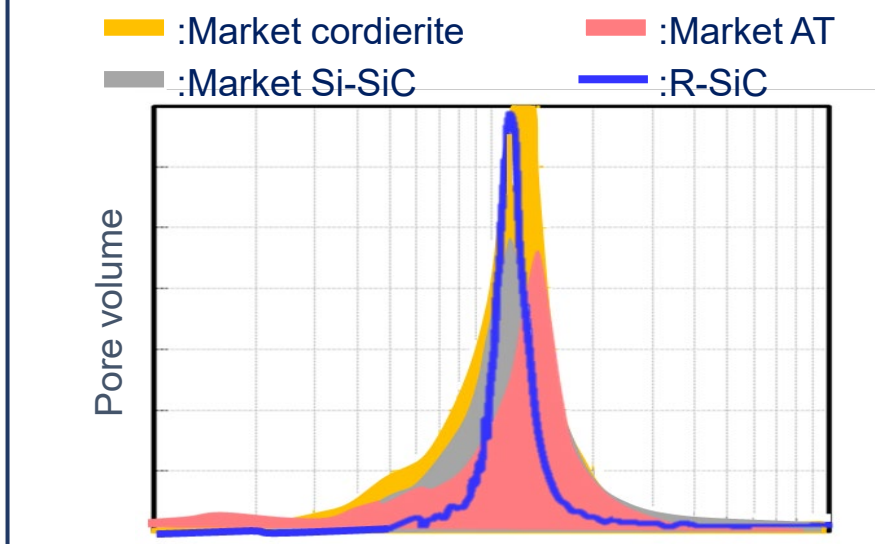
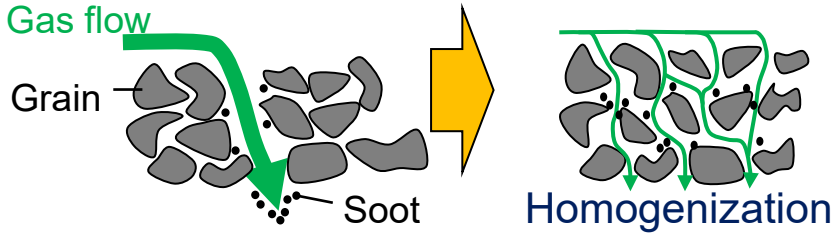


Fig. Comparison of pore size distribution

Heterogeneous
pore distribution

Homogeneous
pore distribution : **R-SiC**

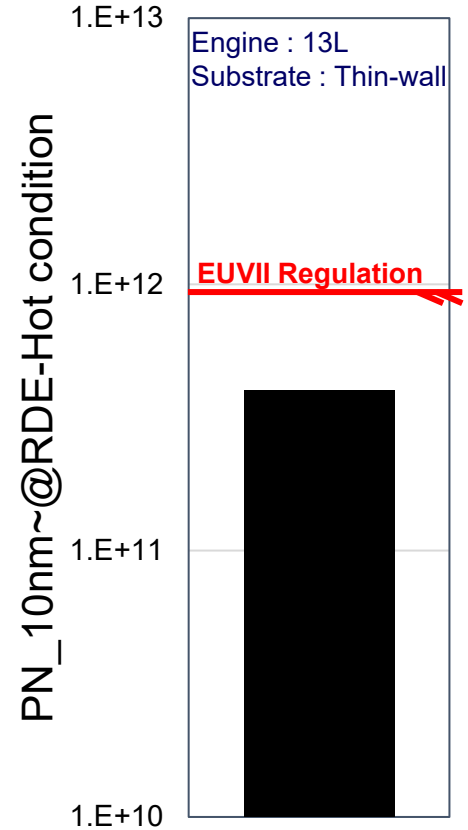


Homogenization of gas

⇒High Filtration Efficiency

Fig. The image of gas flow uniformity of different pore distribution

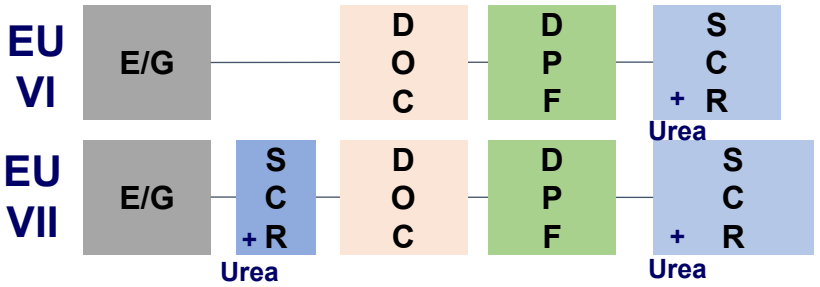
Filtration performance



Challenge for higher filtration performance

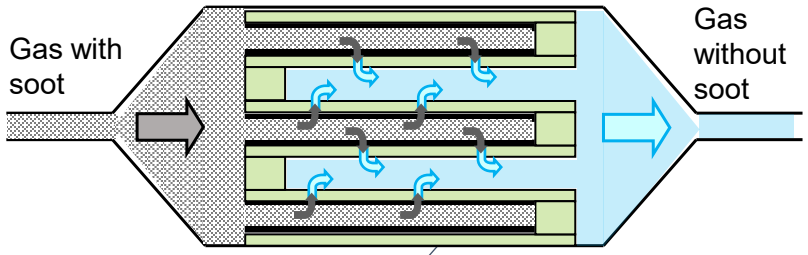
➢ IBIDEN continues investigating higher filtration performance for higher ATS design flexibility.

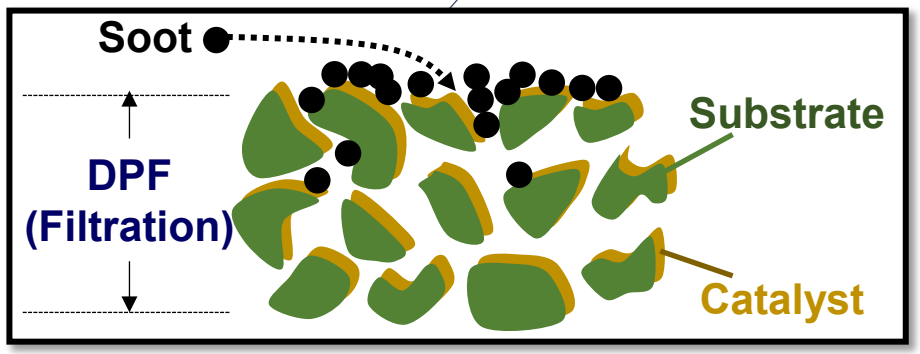
ATS (Assumption)



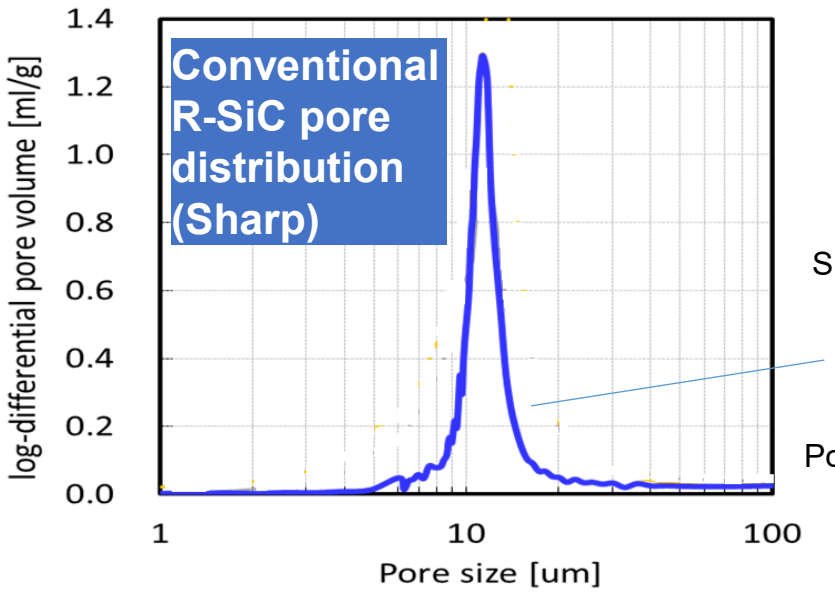
Robust management of engine and ATS can be satisfied by the support of high performance components

PN/PM filtration by DPF



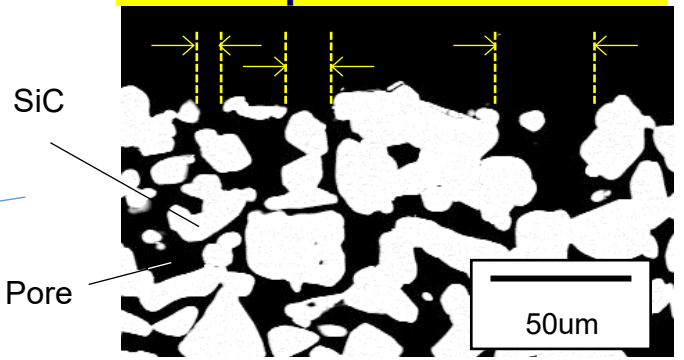


DPF substrate optimization



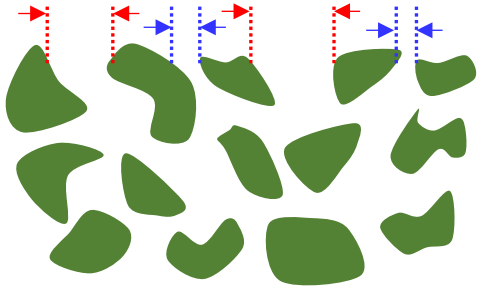
Micro scale

Surface pore size deviation

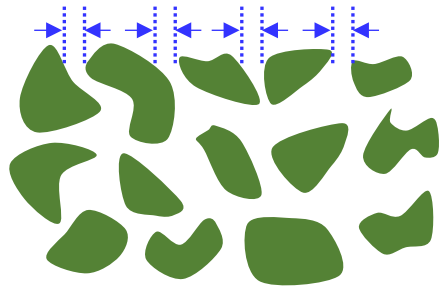


Concept to more High filtration

Conventional



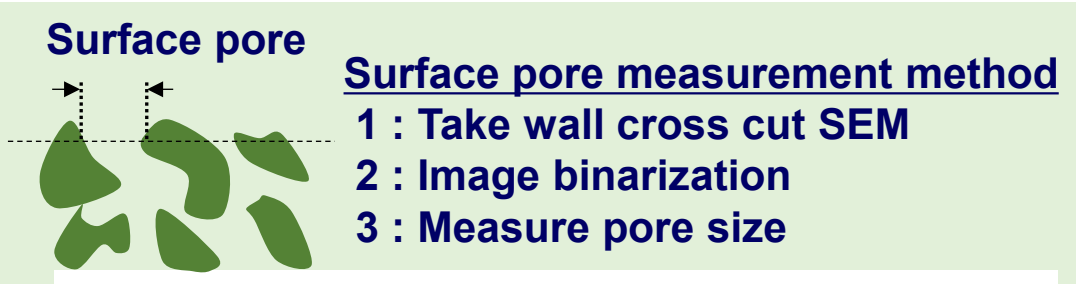
Optimization



Homogeneous surface pore

Surface pore optimization results

- Optimization enables surface pore size more homogeneous with smaller size.



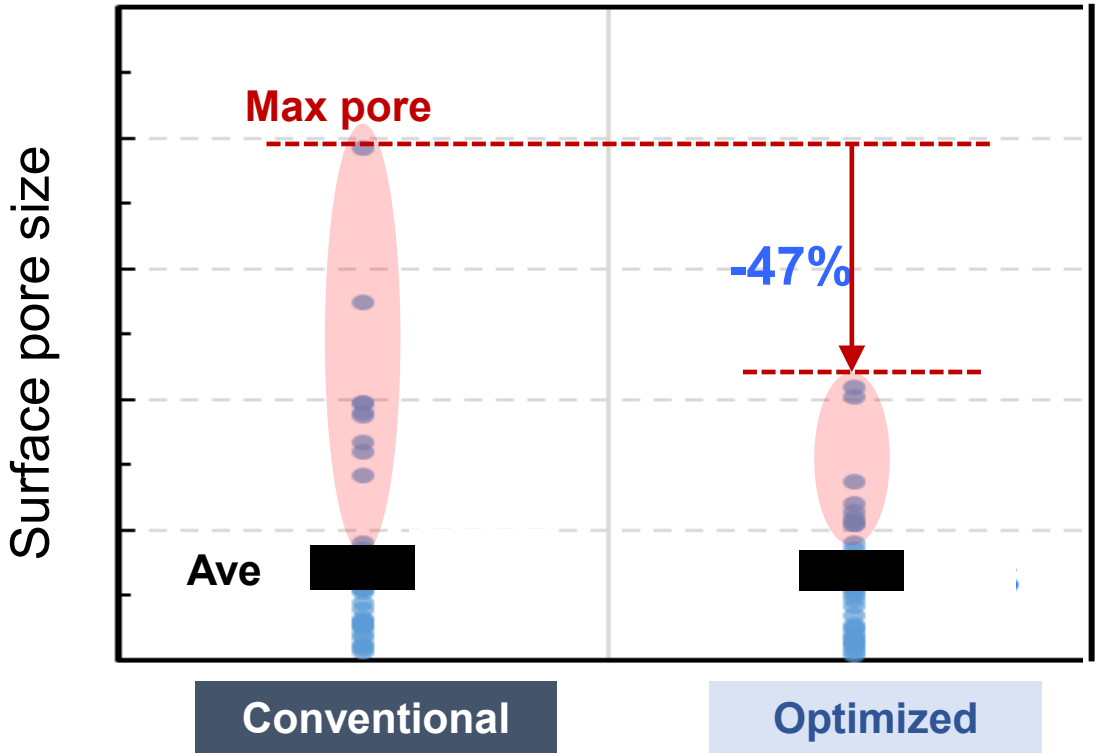


Fig. SEM image of surface pore

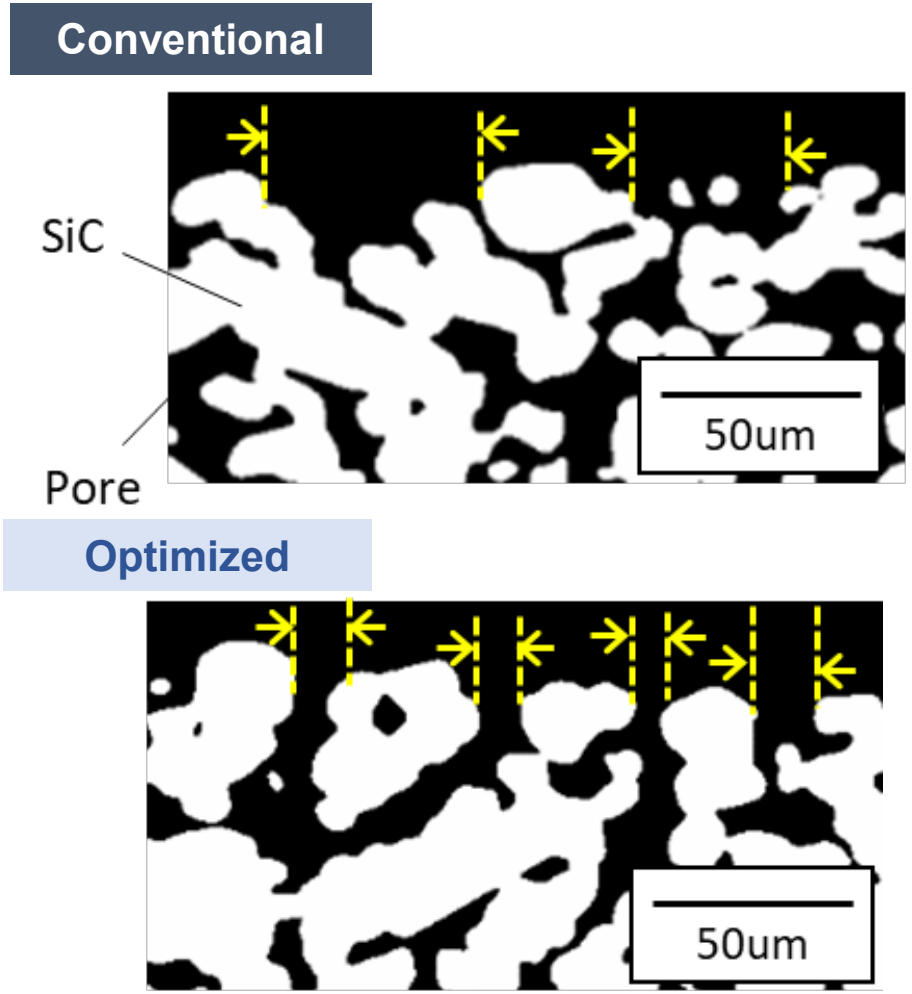
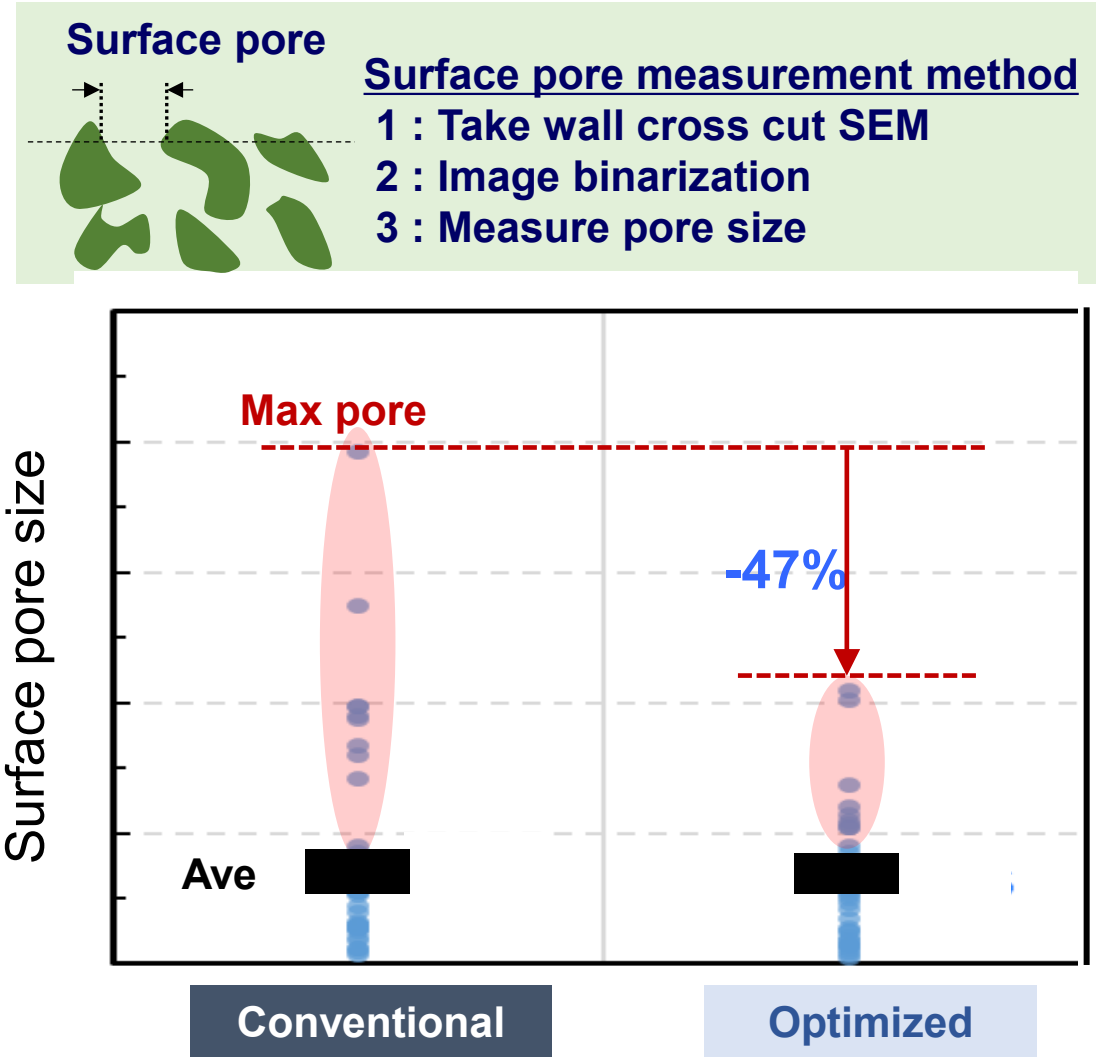


Fig. SEM image of surface pore

Surface pore optimization effect on PN filtration

➢ Optimized pore structure will improve filtration performance.



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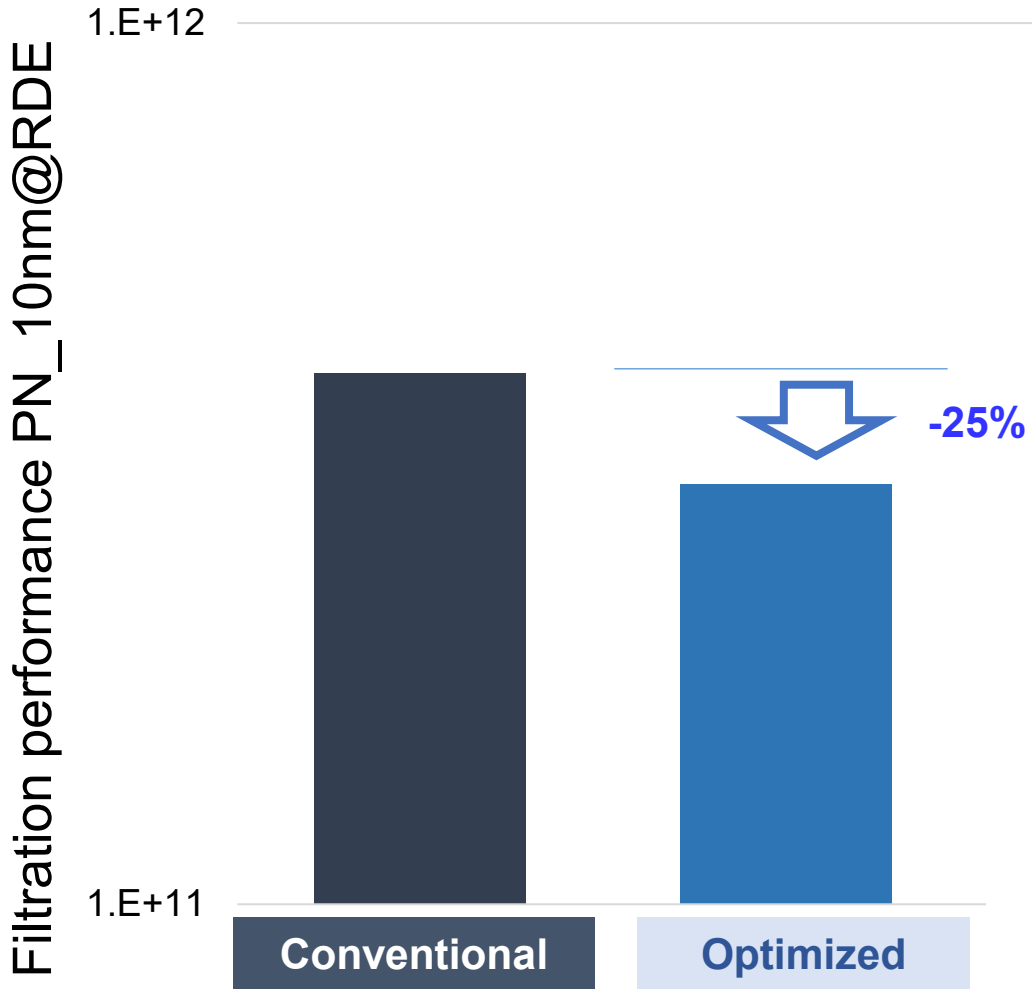
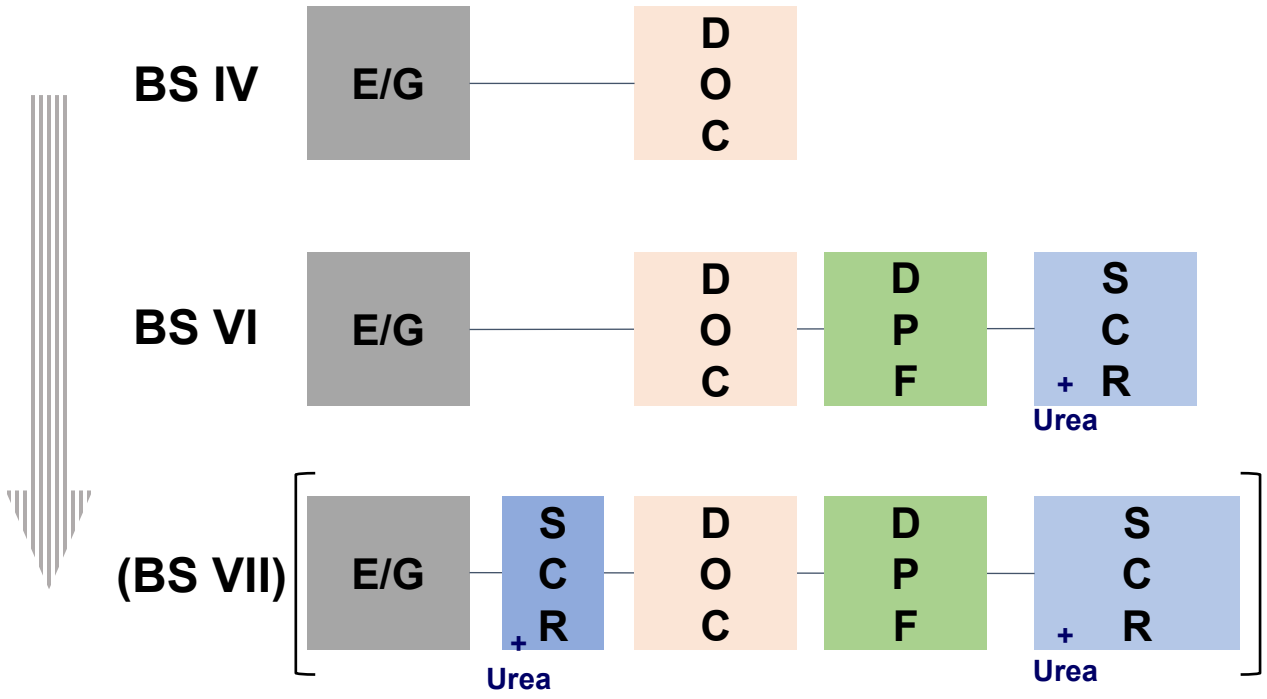


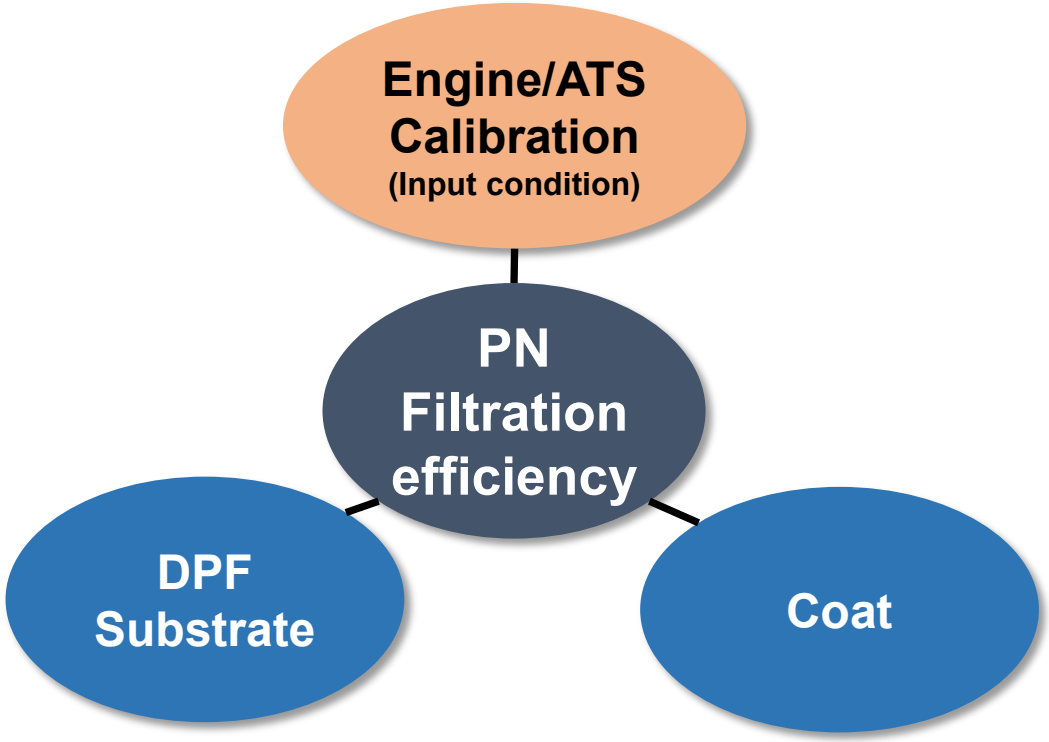
Summary

Norms

ATS trend



PN filtration factor



ATS needs to be more robust as norm becomes strict. IBIDEN continues to investigate improving filtration performance and contribute to robust ATS design.

PN filtration performance relates to DPF input condition DPF substrate and coating.
→ Collaboration within supply chain is important!