Improved Coated Gasoline Particulate Filters for Close Coupled and Underfloor Applications

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Agenda

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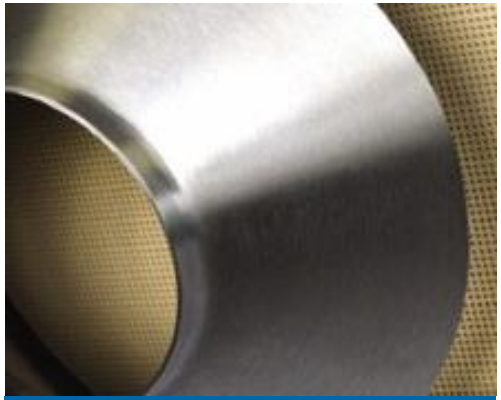
Motivation

Upcoming Legislation

- Worldwide increasing fuel efficiency regulations
- Stringent emission limits
- Stringent OBD criteria
- Implementation new cycles
- Real-Driving-Emissions

Effect on Gasoline Vehicles

- Growing share of GDI's
- Implementation of cylinder deactivation, VVT, Start/Stop
- Less fuel enrichments
- Higher mass flows
- Higher peak exhaust temperatures

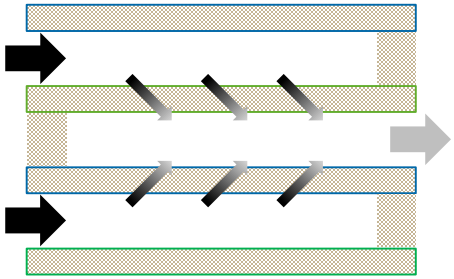


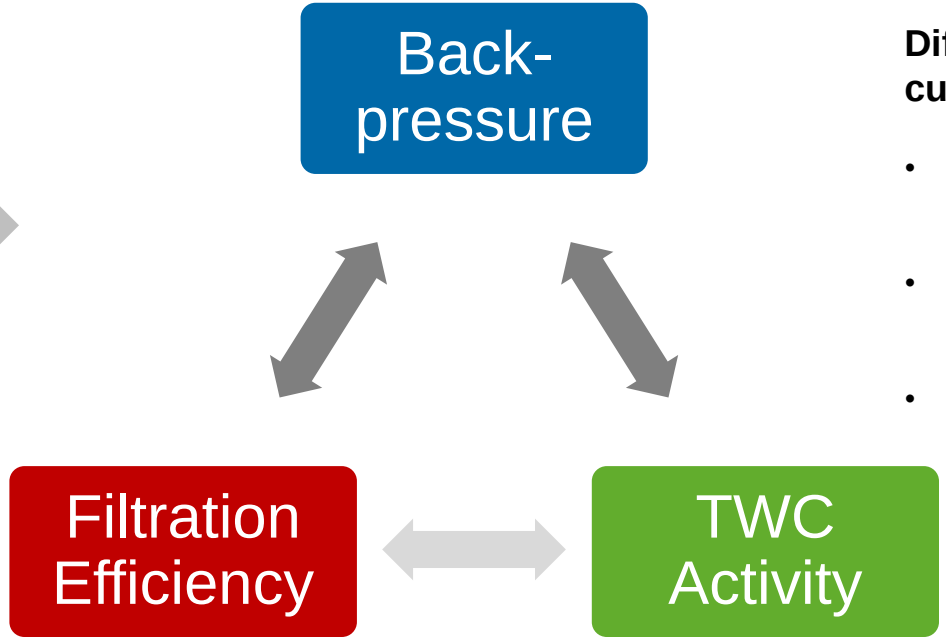
Requirements for Future GPFs

- High temperature stability
- Better CO-/NO_x-activity
- Light-Off
- Dynamic OSC
- Easy to diagnose
- Backpressure
- Filtration Efficiency

Area of Conflict

Coating of Wall-Flow Substrates – e.g. GPF





Different needs require customized technologies

- Special technologies for lowest backpressure
- Portfolio of high three-way active GPF designs
- Formulations for increased fresh filtration efficiency

Exhaust System Layouts

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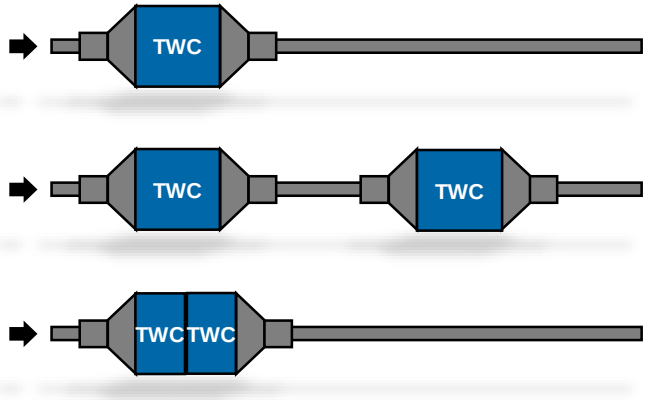
System Layouts BS6*

*GDI + MPI

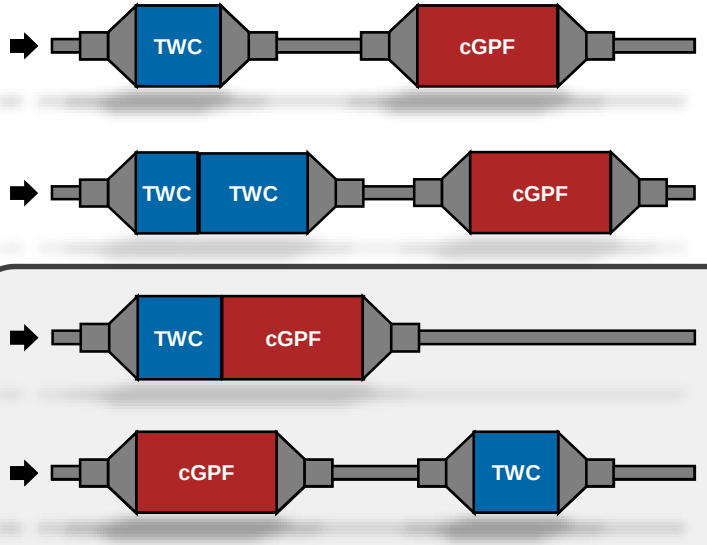


Trends:

- bigger Volumes
- more PGM
- GPF Introduction

System Layouts > BS6-2**

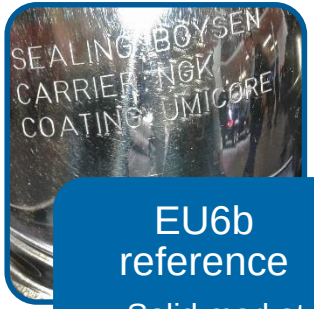
**GDI



Improved technologies required!

Development Process

Based on the prior observations, a new GPF technology, with very high TWC activity, needs to be developed:



EU6b reference

- Solid market position

Alumina & OSM optimization

- Raw material screening

OSC adjustment

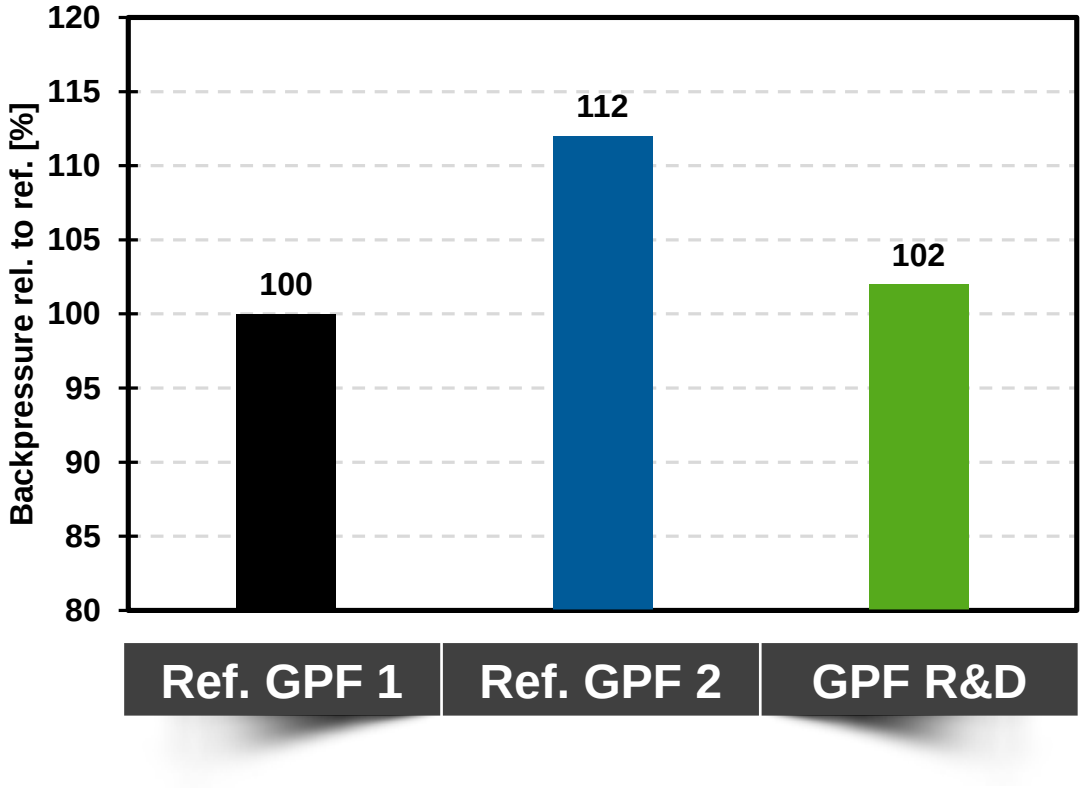
- Determination of best Alumina/OSM ratio

Advanced cGPF

- Thorough testing of new cGPF technology

Test Setup

With cold flow backpressure at 600 m^3/h



Reference GPF 1:

- Optimized inlet zone for improved light-off
- Outlet zone for reduced NO_x emissions

Reference GPF 2:

- higher washcoat loading + more PGM
- Same chemistry

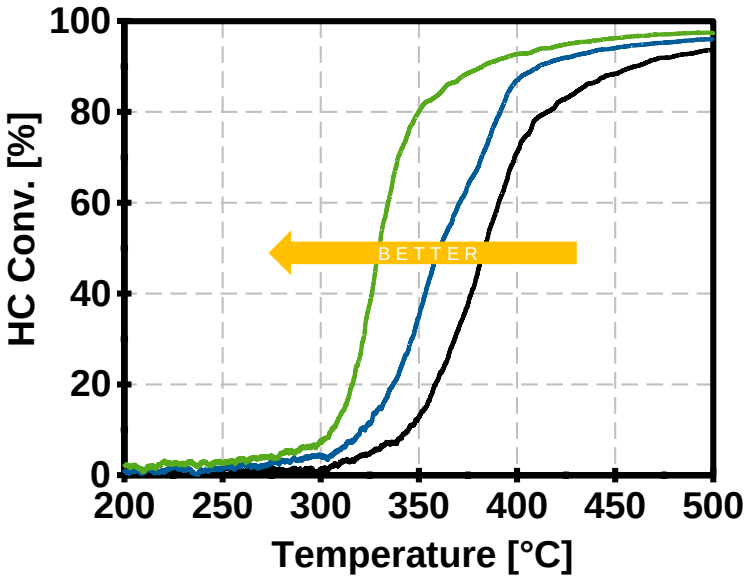
GPF R&D:

- Same washcoat loading as Reference GPF + more PGM
- Advanced chemistry

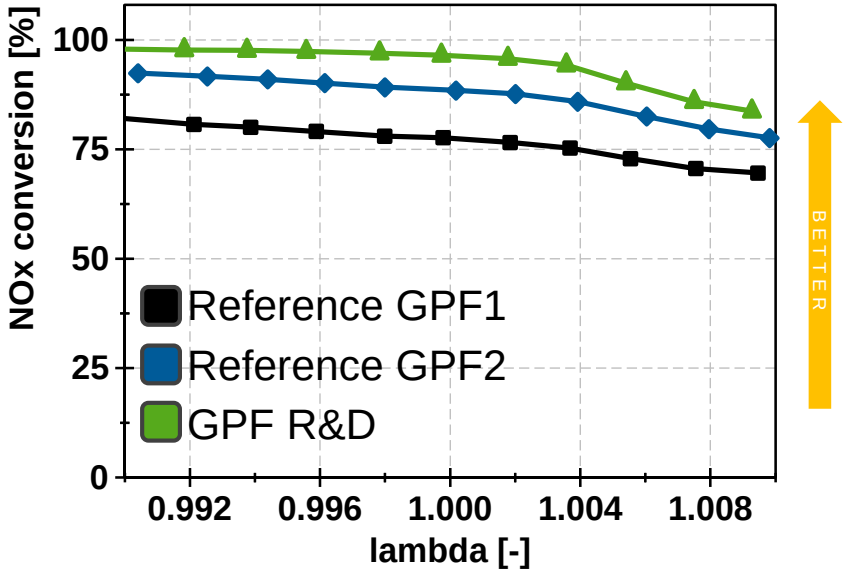
Engine Bench Tests: Light-off | λ-Sweep

Mass flow = 110 kg/h, FUL aged

HC Light-Off



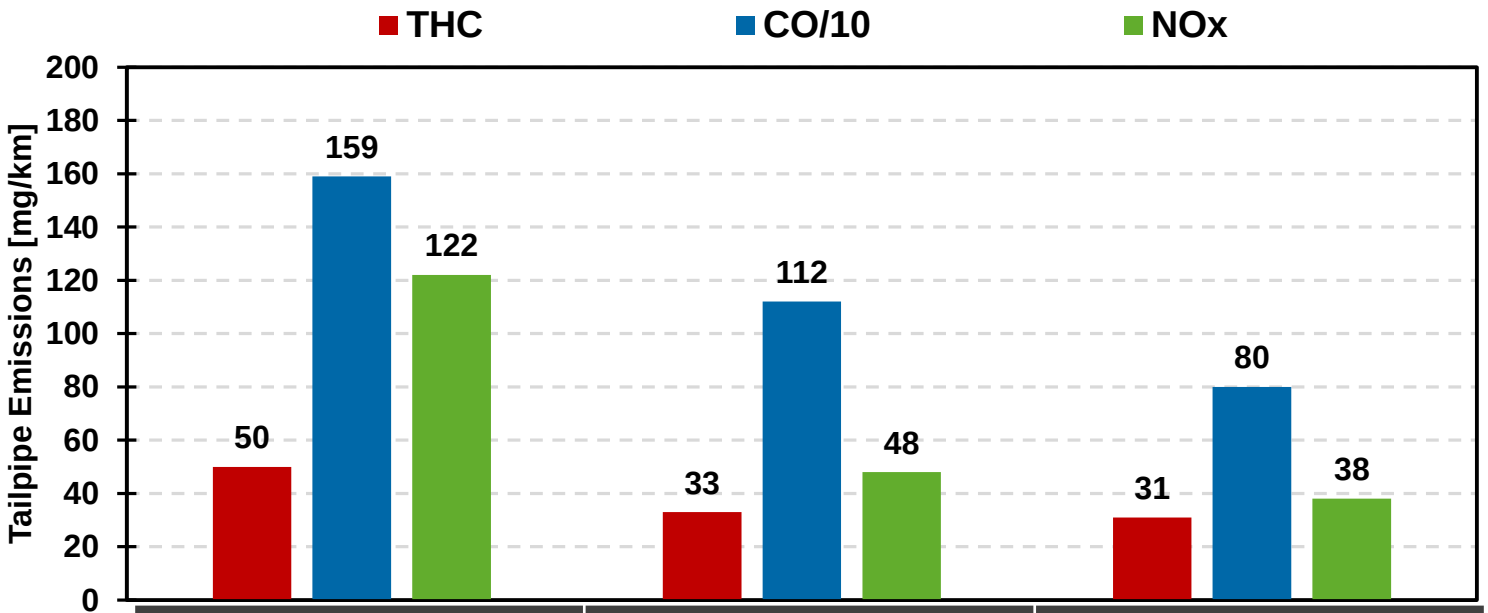
λ-Sweep Test NO_x conversion



- higher washcoat and PGM loading of Ref. GPF1 leads to improved performance
- However, advanced chemistry of R&D reveals biggest benefit in light-off and sweep test

WLTP Emissions at 2.0 GTDI EU6 in CC1

after 76 h fuel-cut FUL aging above 1.000°C bed-temp

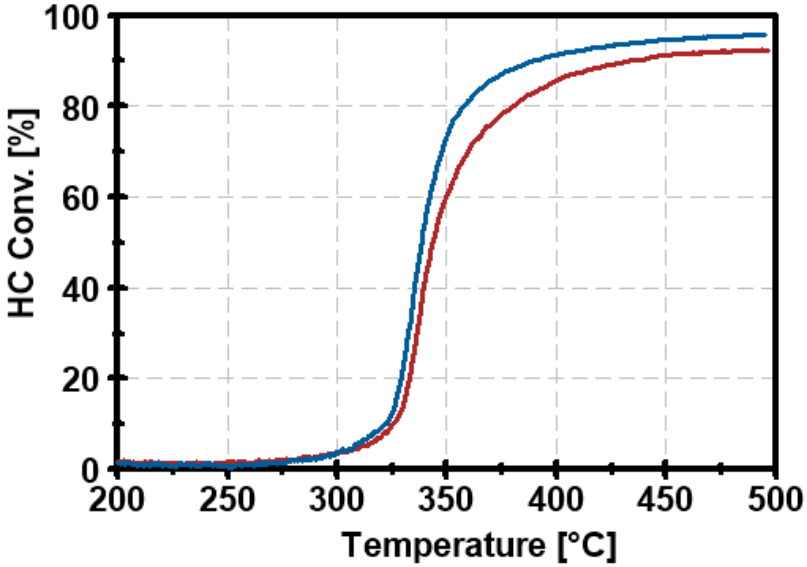


Reference GPF1	Reference GPF2	GPF R&D
---	more washcoat	same washcoat amount
---	higher PGM	higher PGM
---	same chemistry	advanced chemistry

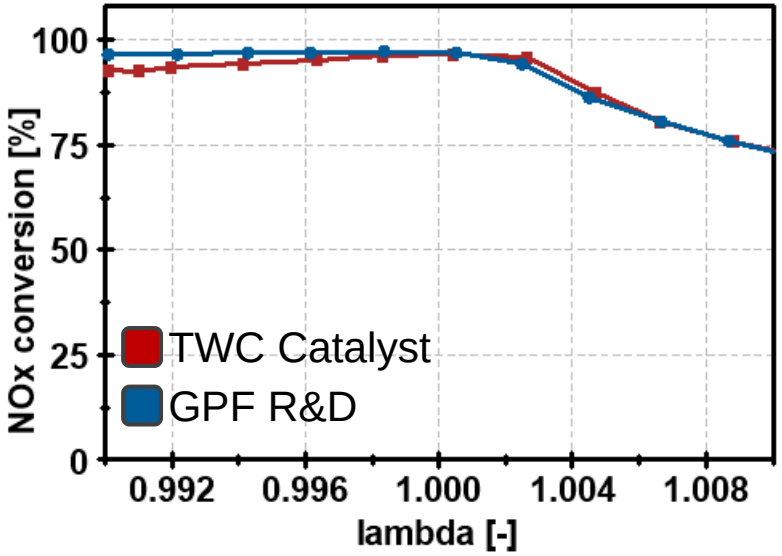
Competition against TWC at Engine Bench

V_{TWC}: 0.8L | V_{GPF}:1.6L | PGM_{TWC} 45 g/ft3 (0/35/10) | PGM_{GPF} 36 g/ft3 0/28/8)

HC Light-Off



λ-Sweep Test NO_x conversion

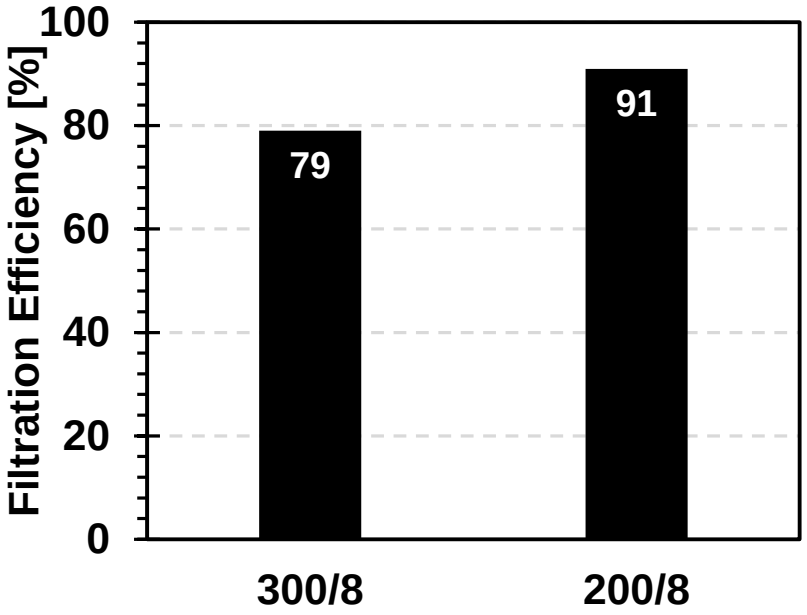


After severe FUL-aging in CC1 position GPF R&D can compete with TWC catalyst

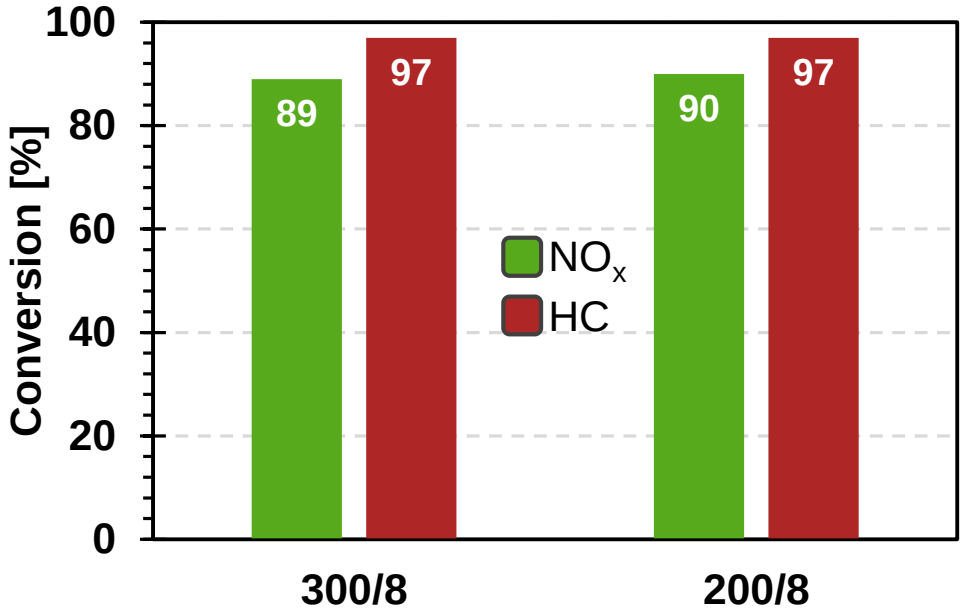
Substrate

High vs Medium Porosity

WLTP Filtration Efficiency



λ-Sweep Test – FUL aged

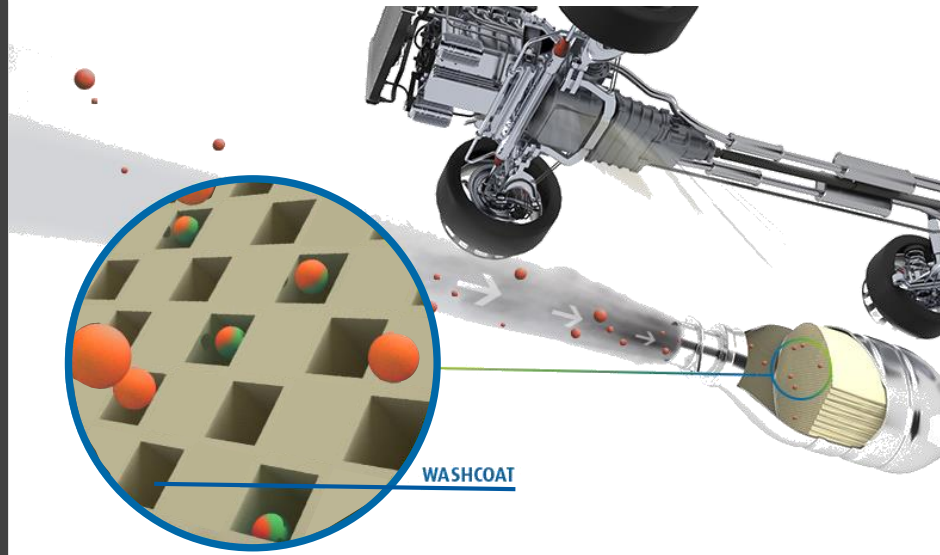


GPF-R&D can be coated on both high and medium porous substrates with low and high washcoat amount for either CC or UFC application

Generally, if high FE is desired, it is appreciated to start with the best substrate!

Summary and Conclusion

- A better cGPF with increased TWC activity is required by the market
- Higher washcoat loading at given chemistry can do better than the reference GPF but results in backpressure penalty!
- Advanced chemistry reveals biggest overall performance improvement at similar backpressure than reference GPFs. Minimizing a trade-off.
- No substrate limitations with new GPF



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Thank you!

Questions?