Portable Nano-Particle Emission Measurement System

EUROPEAN COMMISSION
Horizon 2020 | GV-02-2016 | Technologies for low emission light duty powertrains
GA # 724145

Deliverable No.	D3.5	
Deliverable Title	Suggestion for PN > 10 nm measurement procedure	
Deliverable Date	2019-09-30	
Deliverable Type	REPORT	
Dissemination level	Confidential – member only (CO)	CO
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Status	Final	2019-09-28

Publishable Executive Summary

The PEMs4Nano project addresses the challenge to develop detectors and robust procedures to reliably measure the particle number concentration down to 10 nm in the exhaust gas. To achieve this, and to make the progress to that overall objective more transparent, the project is structured in three focus areas:

- model-guided application (MGA),
- preparation of measurement technology (MT),
- development of measurement procedure and application (MPA).

The simulation approach in *model-guided application* supports building up fundamental understanding of the particle formation, composition, size distribution and transport and generates vital recommendations on the measurement procedure. *Preparation of measurement technology* focuses on the development of the particle number (PN) measurement system itself while *development of measurement procedure and application* addresses the implementation of the new measurement system in the engine & vehicle development process in terms of application and usage.

The scope of this report is to further test the prototype PN 10 nm measurement systems and give recommendations for a reliable measurement procedure. This will clearly enable the industry to get closer to the emissions targets in an early phase in the development of new engines. That would lead to either a more efficient development process or more elegant solutions to reducing particle emissions (or both), due to the better understanding of particles in the exhaust line.

This report ties in with the previous reports D3.3 and D3.4 with a particular focus on investigations of both engines at the engine dyno and vehicles on the chassis dyno with the following objectives:

- Generate experimental data to train and validate the models of the focus area *model-guided application.*
- Application of the new PEMs4Nano PN>10 nm lab (SPCS) and mobile (PEMS) measurement systems at the engine and chassis dyno together with the standard PN>23 nm SPCS and PEMs systems.
- Evaluation of the PN>10 nm emission behavior of GDI vehicles during various driving cycles and sensitivity analysis for different operating conditions.

For the investigations, two state-of–the-art medium sized cars[1], one of the D-segment and one of the M-segment, have been operated on the roller test bench. Both cars are equipped with a high-pressure fuel injection system, an exhaust gas aftertreatment consisting of a three-way catalyst (TWC) and a gasoline particulate filter (GPF) for the D-segment vehicle. Additionally, a prototype engine based on a MY2017 production engine has been tested with the same PN measurement setup and for various sampling locations.

Comprehensive variations of the driving cycles Worldwide harmonized Light Duty Test Cycle (WLTC) and Real driving Emission (RDE) have been performed for two different certification fuels (EU5 and EU6) and three different operating temperature conditions (ambient 23 °C ± 3 °C, 0 °C and -7 °C). The PN>23 nm tailpipe emissions have been compared to the PN>10 nm, and PN>23 nm emissions at the dilution tunnel with constant volume sampling (CVS).

The gathered findings summarized in this report will be used to further improve the measurement technology on the one hand and to contribute to a recommendation for a PN >10 nm measurement procedure for the application in the engine and vehicle development process on the other.

[1] According to the European car segment definition (https://en.wikipedia.org/wiki/Euro_Car_Segment); Homepage accessed on 25th of August.

Acknowledgement

The author would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Type	Partner	Partner Full Name
1	IND	HORIBA	Horiba Europe GmbH
2	IND	Bosch	Robert Bosch GmbH
3	IND/SME	CMCL	Computational Modelling Cambridge Limited
4	IND	TSI	TSI GmbH
5	HE	UCAM	The Chancellor, Masters and scholars of the University of Cambridge
6	HE	ULL	Université des Sciences et Technologies De Lille – Lille I
7	IND	IDIADA	Idiada Automotive Technologie SA
8	IND	HORJY	Horiba Jobin Yvon S.A.S.
9	IND/SME	UNR	Uniresearch BV

This project has received funding from the European Union's Horizon2020 research and innovation programme under Grant Agreement no. 724145.