Portable Nano-Particle Emission Measurement System

EUROPEAN COMMISSION

Horizon 2020 | GV-02-2016 | Technologies for low emission light duty powertrains

GA # 724145

Todo Deliverable No.	PEMs4Nano D4.3	
Deliverable Title	Testing for final validation and robustness evaluation of the equipment developed	
Deliverable Date	2019-12-31	
Deliverable Type	REPORT	
Dissemination level	Confidential – member only (CO)	
Written By	Antonio Pérez (IDIADA) Susanna Paz (IDIADA)	2019-12-20 2019-12-20
Checked by	Rosa Delgado (IDIADA)	2019-12-20
Approved by	Roman Grzeszik (BOSCH) Philipp Kreutziger (HORIBA) Marcus Rieker (HORIBA) - Coordinator	2019-12-18 2019-12-18 2019-12-19
Status	FINAL	2019-12-20

Publishable Executive Summary

The PEMs4Nano project addresses the development of both a new portable device and a laboratory system to detect particles down to sizes as small as 10 nm, together with a robust procedure to measure these particles. Achieving robust and reliable measurements technology and procedures supports the automotive industry to reduce vehicle emissions. In addition, this project will provide a contribution to future regulation on particle emissions as well as a better understanding of particle emissions below 23 nm (with the threshold of at least 10 nm).

IDIADA, as a WP 4 leader, performed complete testing using the technology developed in the WP2 "Measurement technology" through physical testing in the laboratory with the final objective of ensuring the correct operation of the PN measurement system to measure small particles down to 10 nm. Furthermore, additional objectives were:

- Implementation of the final calibration procedure of the equipment for particles down to 10 nm.
- Definition of the testing protocols using the developed equipment.
- Final validation of the measurement procedure and equipment robustness evaluation.

In this deliverable D4.3, the results of the testing campaign performed at IDIADA are presented and the analysis of the new equipment developed within the PEMs4Nano project was successfully done by looking at these results. Specifically, the structure of the deliverable is as follows:

- Brief explanation of the testing preparation and procedures to be followed during the testing campaign
- Presentation of the testing results and the analysis
- Analysis of the PN results of the PaREGEn demonstrator vehicle which was tested at IDIADA with all the PEMs4Nano equipment developed (the Lab PN10 and the two PEMS PN10 prototypes).

With all the results obtained with the PEMs4Nano laboratory and on-board systems, this deliverable contains enough data to ensure a good handleability and performance of the equipment, capable of measuring particles down to 10 nm without suffering any specific malfunction during the whole testing campaign.

Furthermore, different vehicle technologies were tested, and a large variety of cycles were performed by the new measurement systems at IDIADA, which allowed the project consortium to carry out analysis in a wide range of conditions both in the laboratory and with the on-board PN10 equipment.

WLTC Test results – PN analysis

As an example of one of the different results from the testing campaign performed, one of the testing layouts is presented in Figure 1 and the corresponding WLTC test results of a 1.0L gasoline direct injection (GDI) vehicle with gasoline particle filter (GPF) are presented in Table 1.

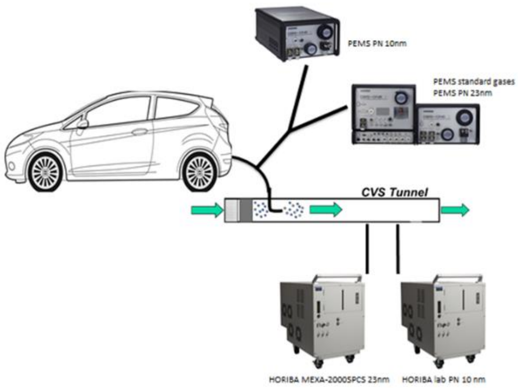

Figure 1. Testing layout

Figure 1 above shows the different equipment configuration and the corresponding sampling points used to measure PN emissions.

The individual results of each test performed on the chassis dynamometer for this vehicle and specific cycle are shown in the following table:

Table 1. WLTC tests results of a 1.0L GDI vehicle with GPF by the different PN technologies

	WLTC Cycle results			
Num. Test	SPCS PN 23 (pk/km)	PEMs4Nano SPCS PN10 (pk/km)	PEMS PN10 (pk/km)	PEMs4Nano PEMS PN10 (pk/km)
IB_190402_011	1,1E+10	1,3E+10	7,8E+09	9,8E+09
IB_190403_008	1,2E+10	1,4E+10	9,4E+09	1,1E+10
IB_190415_008	1,3E+10	1,5E+10	9,3E+09	1,2E+10

From the first three tests, the average values have been calculated and are represented in the following charts:

Figure 2. Comparison of WLTC tests of a 1.0L GDI vehicle with GPF by the different PN technologies

Facts & Comments:

- ✓ **23 vs 10 nm comparison →** Both SPCS and PEMS technology show an increase in PN with new Sub-23 nm device.
- ✓ **SPCS vs PEMS →** More particles with SPCS system rather than PEMS (both for 23 and 10 nm technology) is shown.
- ✓ **15 to 21% increase** by measuring PN10 nm by the PEMs4Nano system compared to standard PN 23 nm.

Another important result to show is the second-by-second PN10 nm emissions through the cycle measured by the laboratory system (SPCS). Figure 3 below represents the PN10 nm and PN23 nm concentration (#/cm^3), the corresponding total PN per distance (#/Km) and the vehicle speed.

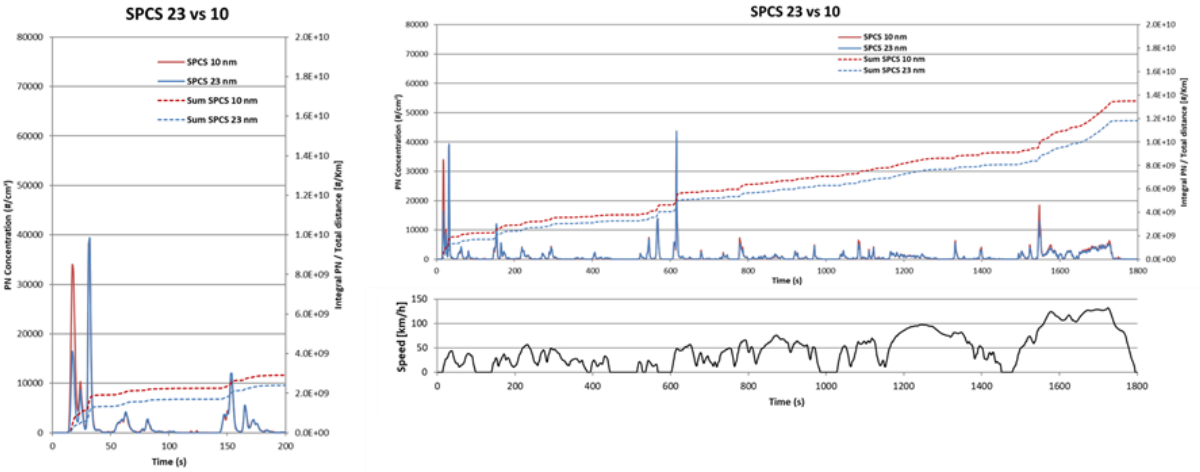

Figure 3. Example of PN 10 nm emissions through a WLTC measured by the laboratory system (SPCS)

The main conclusions are that on the one hand, sub-23 nm particles are generated mainly at engine start and acceleration phases and, on the other hand, accumulated PN values (#/Km) of an individual test are similar and consistent to the average values (see Table 1).

Acknowledgement

The author(s) 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.