PROJECT

IMPECC2

Infrared Microsystem for Polluting Emission Control on Cars 2

**Funding:** European (6th RTD Framework Programme)

**Duration:** Dec 2003 - Feb 2006

**Status:** Complete with results

**Total project cost:** €3,703,629

**EU contribution:** €1,399,814

**Call for proposal:** FP6-2002-TRANSPORT-1

**CORDIS RCN:** 74298

**Background & policy context:**

In order to address the future near-zero emissions for transport vehicles, a fast response, onboard measurement system for exhaust gas components is an excellent tool for the control of internal combustion engines (ICE) and advanced exhaust after-treatment systems, as well as the specific vehicle emission performances (on board diagnostics, for example).

This system is intended to achieve accurate and reliable exhaust gas emission measurements for the detection of several gas species, respecting competitive costs as well as the necessary required durability. To be able to fulfil these stringent requirements an onboard gas sensor, based on the infrared optical technology, has been developed. Narrow band emitters, based on a resonant micro-cavity design, have been realised for the respective absorption bands of the various gas constituents to be detected and measured with a single broad spectral band detector, also developed within the framework of this project.

This technology is applicable for a variety of transport modes: road and railway, marine propulsion sector, as well as the aircraft industry. The sensor system specifications have been defined to comply with those various fields of applications. Beside exhaust gas particles, fast sensor response times are targeted to transfer the advantage of fast optical measurements into in-situ internal combustion engine control strategies.

**Objectives:**

The sensor system specifications have been defined to comply with the various fields of applications. Fast sensor response times are targeted on one side to transfer the advantage of fast optical measurements into in-situ ICE control strategies. On the other side, accurate and absolute low-level exhaust gas concentration values are targeted for exhaust after-treatment control and diagnostics.

The reference transparency measurements, necessary to correct for any opacity changes in the optical path, shall also be used to extract the information on the exhaust gas particle content. The sensor will comply with the typical automotive reliability requirements.

The entire sensor system was developed in respect of these technical boundary conditions but also to comply with the typical automotive environmental (packaging, temperature, vibrations, robustness, durability, etc.) specifications and the representative commercial targets.

**Methodology:**

Narrow band emitters, based on a CdxHg1-xTe resonant micro-cavity design, have been realised for the respective absorption bands of the various gas constituents to be detected and measured. These emitters consist of a light-emitting active heterostructure layer and two multilayered Bragg mirrors of a thickness of about 5 um coupled directly onto a pumping laser diode. A low-cost detector, based on the bolometer technology and suitable to work with this sensor system, had been defined and realised in the frame of this project.
The sensor system integration into the engine exhaust system, together with the adequate electronics consisting of the emitter laser diode drivers, the detector amplifiers and the signal processing, have been developed.

A probing chamber containing the exhaust gases is inserted into the optical path between the narrow band emitters and the broadband detector. The exhaust gas is supplied to the probing chamber through a conditioning unit. The exhaust gas-conditioning unit controls pressure and temperature and prevents condensation, particularly in cold start conditions. Systems were developed to prevent particles from blinding the windows among which mechanical, aerodynamic or chemical systems.

**Parent Programmes:**
FP6-SUSTDEV-3 - Global Change and Ecosystems

**Institute type:** Public institution  
**Institute name:** European Commission  
**Funding type:** Public (EU)

**Lead Organisation:**

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EU Contribution: €0

Key Results:

In summary, the signal at around 170 nV/ppm was rather strong, but with high noise content. Even with the complex temperature control, the long-term stability and repeatability were poor.

For the detection of particles, opacity measurements with the selected optical and the related signal processing system are projected to detect particles in the required area for current and future engine technologies.

In the frame of this project, the following risks were identified:

- Sensor targeting tailpipe out application
  - requires high sensor sensitivity, accuracy and robustness
  - complex sensor temperature management required
  - Emitters (micro-cavity)
  - cross sensitivity to other gas species
  - relatively low optical power
  - increased requirements on sensor design (high sensitivity and accuracy), resulting in high system complexity

- Bolometer detector currently performs > 20% below requirements

- Data acquisition and signal processing
  - new sensor requirements (tailpipe out) and the current performances of the emitters and detectors are considerably driving up the requirements on the electronics, i.e. modulation, sampling, etc.
- NOx measurements are not possible because of the interaction with water vapour (H2O) in the exhaust.

Documents:
- Executive Publishable Summary (Final report)

**STRIA Roadmaps:** Vehicle design and manufacturing
**Transport mode:** Multimodal transport
**Transport sectors:** Passenger transport, Freight transport
**Transport policies:** Environmental/Emissions aspects
**Geo-spatial type:** Network corridors