**EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope**

Selected Research Topic number: **SRT-i17**
Version: 1.0

# Title: Metrology for airborne molecular contamination in manufacturing environments


## Abstract

Control of Airborne Molecular Contamination (AMC) is crucial for the semiconductor, photovoltaic and LED industries that require ultra-clean manufacturing conditions. Real-time AMC monitoring is needed to enable corrective actions to be made before the production process is affected. Recently introduced ultra-sensitive spectroscopic techniques are key technologies in this respect and their effectiveness to monitor multiple critical contaminants will be further extended. New dynamic standards need to be developed for selected AMC in order to validate these methods. In this way, the uptake of a new generation of ultra-sensitive instruments to control AMC should be facilitated, hence removing barriers to efficient manufacture in ultra-clean environments.


## Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on "Grand Challenges" related to Industry & Fundamental Metrology on pages 13 and 40.


## Keywords

Airborne molecular contamination (AMC), trace levels, online analysis, clean room, semiconductors, photovoltaics, LED industry, reference materials.


## Background to the Metrological Challenges

Technological progress in several high tech industries is enabled, if not driven, by the ability to operate at ever smaller scales. This also introduces new challenges in the metrological realm. Airborne Molecular Contamination (AMC) is chemical contamination in the form of vapors or aerosols that has adverse effects on products, processes or instruments. Control of AMC is crucial for the semiconductor-, photovoltaic- and high brightness and organic LED industries. Adverse effects of AMC include corrosion of metal surfaces on the wafer, and the formation of contamination layers on surfaces like optics and wafers after reaction/condensation.

There are many types of AMC including acids, bases, condensables, dopants and metals, which originate from sources including process chemicals, filter breakthrough, building and clean room construction materials and operating personnel. AMC are typically present at (sub) parts per billion making their detection challenging. Regulations, know-how and analytical capabilities are much less well developed than in the particle contamination field.

To control AMC, products are manufactured in a controlled environment (clean room). They are constructed and used in a way so as to minimise the introduction, formation, and retention of contaminants such as AMCs and particles inside the room. The growing concerns about AMC have led to more stringent specifications by exposure tool suppliers with measurement targets changing from the parts per billion to the parts per trillion level.

AMC monitoring can be divided into on-line and off-line analysis methods. Off-line methods enable part per trillion sensitivities but the required sampling and measurement times are long and measurements can be labour-intensive. Such methods include TD-GC, TD-GC/MS and TD GC-FID. On-line methods enable timely intervention but generally have lower sensitivities as the contaminants are not accumulated. On-line analysis methods include Ion Mobility Spectroscopy, Chemiluminescence (for $NO_X$) and Laser Photoacoustics (Ammonia).

Currently instrumentation is often not fit-for-purpose due to high costs, large size or limited reliability. Therefore, an AMC monitor that provides analysis and feedback within approximately one minute would allow for a timely detection of contamination, for the determination of the contamination cause, and would enable corrective actions to be made before valuable data is lost and/or yields are affected.

Recently, several ultra-sensitive spectroscopic methods have reached a “proof of concept” level for use as on-line methods. These include cantilever-based photoacoustics, noise-immune cavity-enhanced optical-heterodyne molecular spectroscopy (NICE-OHMS), and spectrometers based on frequency comb lasers.

## Scientific and Technological Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-Protocol.

The JRP shall focus on the traceable measurement and characterisation of airborne molecular contamination in manufacturing environments such as clean rooms in the semiconductor, photovoltaic and LED industries.

The specific objectives are

1. To develop detection technique(s) for relevant Airborne Molecular Contaminations (AMCs) with suitable sensitivity and time-resolution.
2. To develop dynamic generation methods and reference materials for relevant AMCs at trace levels, for measurement method validation and calibration.
3. To develop suitable sampling techniques for the measurement of trace levels of AMCs.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation or by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- transfer knowledge to the semiconductor, photovoltaic and LED sectors.
- feed into the development of urgent documentary standards through appropriate standards bodies

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

## Time-scale

The project should be of up to 3 years duration.