Fourth MetAMC newsletter

Airborne molecular contamination (AMC) is chemical contamination in the form of vapours or aerosols that has adverse effects on products, processes or instruments. Examples of possible adverse effects include the corrosion of metal surfaces on the wafer, and the formation of contamination layers on surfaces like optics and wafers after reaction/condensation. Industrial sectors for which the control of AMC is crucial include the semiconductor-, nanotechnology-, photovoltaic- and high brightness and organic LED industries. MetAMC – a three years project of 2.9 Mio € has started in May 2013 within the European Metrology Research Programme (EMRP). The project aims to measure AMCs at trace levels in clean room environments by mainly laser methods. It encompasses a multitude of national metrology institutes and other stakeholders.

Recent progress in laser-based quantitative molecular spectroscopy has brought the detection limits of typical contaminants to a level that meets the industrial need for AMC measurements.

To meet the project goals, the following tasks will be performed during the project:

- ✓ Compare state of the art optical spectroscopic techniques for AMC measurements.
- ✓ Optimizing the chosen techniques in clean room measurement campaigns at collaborator facilities.
- ✓ Develop AMC detection techniques beyond the current state-of-the-art.
- ✓ Create reference materials at relevant concentration levels traceable to the SI units.

The results of the project will be available to the European stakeholders in the semiconductor industry, in micro fabrication, and for manufacturers of optical instrumentation. In addition to developing new measurement instruments and services, the project will provide good practice guides on detection and generation of AMCs, organize workshops and training courses as well as help standards organizations to produce new standards.

Please forward this newsletter to your colleagues. Additional information on MetAMC and the partners can be found on the project homepage http://www.ptb.de/emrp/metamc.html.

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The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

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Research highlights

Internal ammonia comparison

Ammonia is one of the most important airborne molecular contaminants. Its sources include process chemicals, atmospheric air and personnel working in the facility. Yet, measurement of trace levels of ammonia in a clean room is a challenging task due to the affinity of ammonia for typical materials used in a gas flow system and the measurement cell of the analytical instrument. In November 2015 a comparison was organized at VSL to assess the suitability of the measurement methods for ammonia developed within MetAMC and compare these with a commercial instrument. The developed instruments were a photoacoustic spectrometer (VTT and Aalto University), a cavity-enhanced absorption spectrometer (VSL) while the commercial instrument is based on cavity ring-down spectroscopy (PTB). Using a split flow configuration, instruments were challenged with the same low levels of ammonia (0-500 ppb[1]) in a matrix gas of nitrogen or air and using either dry conditions or with added humidity (100 ppm). All three systems under test showed a fast time response to step changes in ammonia. However, the amount fractions indicated by the instruments showed differences and these differences were also matrix gas dependent. Data evaluation is ongoing.

Dynamic reference gas generation at NPL

At NPL, a portable dilutor is being developed for generating reference standards of reactive gases such as ammonia and formaldehyde at trace concentrations (< ppm). The device is based on a binary network of critical flow orifices. The design of this network allows for an internal self-referencing calibration and will achieve dilutions of up to 100 to 1 with a target relative standard uncertainty of ± 0.1 %. This new approach avoids the uncertainty generated by setting and controlling the flow which is present in devices based on variable flow elements. The minimal internal volume and reduced surface area of components ensures that generated reference standards will achieve equilibrium over shorter timescales. The device will be used to dilute reference standards of key airborne molecular contaminants stored in high pressure cylinders at 10 ppm where these mixtures are stable. There are plans to add on additional dilution modules to the device to increase the dilution ratio from 100 to 1 to 10000 to 1. This will target sub ppb concentrations required for calibrating monitoring instrumentation in clean room environments.

Highly sensitive NICE-OHMS detection at NPL

High sensitivity detection of trace gases can be performed using different optical cavity enhanced techniques which use an external cavity to increase the effective absorption path length. At NPL, the cavity enhanced method being developed is NICE-OHMS (noise-immune cavity enhanced optical heterodyne molecular spectroscopy). NICE-OHMS is a novel cavity enhanced method that uses high frequency modulation spectroscopy where the modulation frequency is equal to the cavity free spectral range. It is expected that this method should achieve ppb sensitivity in shorter measurement times than cavity ring-down, and ppt sensitivity in a fully optimized system.

[1] Here ppm, ppb, or ppt denote amount fractions:
1 ppm = 1 µmol/mol; 1 ppb = 1 nmol/mol; 1 ppt = 1 pmol/mol

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Dissemination of project results

Stakeholder workshop

The MetAMC consortium held a stakeholder workshop as a pre-congress workshop to the Cleanzone 2015 event at the Messe Frankfurt on Monday 26th of October 2015. About 25 people from 9 different countries attended the full-day event including AMC experts from the industry and several new stakeholders.

The workshop featured 12 oral presentations including a key talk on AMC issues in microelectronic manufacturing from stakeholder CEA-Leti. Since most current AMC detection techniques are not based on optical technology, but rather on ion mobility spectrometry, mass spectrometry or gas chromatography, the workshop provided new insights for many stakeholders regarding measurement capabilities of optical systems. Stakeholders were positive about considering optical detection of AMCs in future planning of AMC monitoring and control in their clean room facilities.

Follow this link to download the presentations (password available from nils.luettschwager@ptb.de).
We kindly thank all participants for their interest, helpfull feedback, and fruitful discussions!

Cleanzone trade fair

The Cleanzone, which started on Tuesday the 27th of October in Frankfurt, Germany, is a key event on clean room technology in Europe. The Cleanzone is an international two-day trade fair and congress on clean room technology with this year around 730 visitors and 90 exhibitors.

MetAMC was showcased by two oral presentations and a booth with a demo model of a mid-infrared OPO laser from HCP for AMC detection and 6 posters offering detailed information on the project. Measurement, generation and sampling of AMCs turned out to be a new concept for most of the Cleanzone 2015 participants. MetAMC partners were engaged in dozens of discussions focusing on the AMC issue starting from the very basics up to very advanced details on measurement and generations capabilities.

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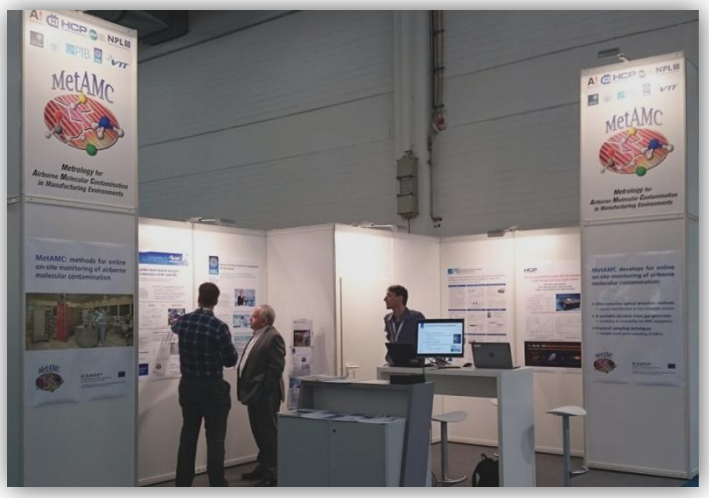

The MetAMC presence on the Cleanzone led to increased awareness on the AMC issue and some consultants used our work to justify the need for AMC control for their customers. Some visitors also expressed their interest specifically in AMC related measurements. It is anticipated that a number of these leads will lead to an actual consultant service and/or long term collaboration.

It is evident that the impact of AMCs on the production processes in clean rooms will be increased in the future and it is expected that there will be new project proposals under EMPIR based on the findings of MetAMC project. Several stakeholders were interested in participating in such a project and discussions on possible content were initiated. Feel free to contact us, if you would like to participate in a follow-up project to MetAMC.

Contact and further information

This is a newsletter about on-going work and development of the MetAMC project which is carried out by the following partners / institutions:

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