
Publishable Summary for 14SIP01 Vacuum ISO

Technical Specifications for quadrupole mass spectrometers and outgassing rates for assessing the quality of vacuum environments

Overview

The purpose of this project was to develop two Technical Specifications (TS) at the ISO level; the first TS was on how to characterise and calibrate quadrupole mass spectrometers (QMS), and the second was about how to perform traceable outgassing rate measurements. The project enabled the development of the two TS by discussing the results of the former project IND12 "Vacuum metrology for production environments" with the pertinent community of manufacturers and users of QMS in close cooperation with ISO TC 112. The two related TS will allow the improvement of materials for the semiconductor industry and make the control of partial pressures in industrial processes more reliable. The Technical Specifications will also help manufacturers of QMS to improve their metrological performance.

Need

Key outputs from a previous EMRP project IND12 Vacuum (Vacuum metrology for production environments) were guidelines on how to characterise and calibrate QMS and how to perform traceable outgassing rate measurements. QMS are needed to perform outgassing rate measurements therefore they were a prerequisite for the latter and so the results were closely related.

The ISO Technical Committee 112 "Vacuum Technology" (ISO TC 112), the primary supporter of this project, has requested the implementation of the results from the project IND12 into Technical Specifications so that a wider community may use the results from the project and to ensure that the necessary steps to improve the traceability of partial pressure and outgassing rate measurements are taken.

The need for standardised procedures to characterise and calibrate QMS was highlighted in the results of an end user questionnaire conducted within IND12. The end users represented the field of high energy accelerators and fusion machines, suppliers of Extreme ultraviolet (EUV) components, of positioning devices of samples in vacuum chambers and research contract services from industry, (i.e. industries involved in production of semiconductors). In addition, IND12 demonstrated several metrological problems for QMS. It was concluded that particular care needs to be taken to overcome these problems in order to obtain valuable and reliable results for QMS and that some of these problems can only be solved by standardised procedures to characterise and calibrate QMS.

Outgassing rate measurements, which were, in the past, mainly performed by scientists in order to achieve very low pressures in vacuum systems, nowadays have great importance in industry; in particular, for EUV-Lithography used in wafer illumination and for high energy accelerators used in cancer therapies. The results obtained within IND12 identified suitable traceable and validated methods for outgassing rate measurements for use by such industries, however in order to support comparability between outgassing rate measurement systems, using different methods, standardisation is required.

Objectives

The overall objective was to create impact from the results of EMRP project IND12 Vacuum incorporating measurement techniques into formal ISO Technical Specifications. These results were explained to and coordinated with experts from other countries not involved in IND12. This was carried out within the working group 2 (WG 2) "Vacuum Instrumentation" of ISO TC 112 "Vacuum Technology" which is the group responsible at the ISO level for technical drafts for this field.

This project addressed the following objectives:

1. To incorporate the results obtained for the characterisation and calibration of QMS as part of EMRP project IND12 into ISO/NP TS 20175 in order to support their wider dissemination and uptake
2. To incorporate the results obtained for the procedures of outgassing rate measurements as part of EMRP project IND12 into ISO/NP TS 20177 in order to support their wider dissemination and uptake

Having achieved these objectives the accuracy of partial pressure measurement in vacuum will increase in all fields and will make outgassing rate measurements more reliable.

Results

Objective 1 - To work with ISO TC 112 to develop a Technical Specification for the characterisation and calibration of QMS.

To fulfil the objective, two successive versions of working drafts were developed, the first in October 2015, the second in May 2016. The first draft was discussed by the Working Group 2 (WG 2) members of "Vacuum Instrumentation" of ISO TC 112 in November 2015. The comments were considered in the succeeding working draft. This was published on the website of the project and uploaded on the Livelink website of ISO. Besides the Working Group 2, the wider community of manufacturers and users of QMS and researchers who use QMS were asked to comment by November 2016. The comments were discussed at a workshop from Jan 30 - Feb 1, 2017 and at the following WG 2 meeting on Feb 2-3, 2017. As a result of these discussions, a new draft was developed and put to vote within ISO TC 112 WG 2. The WG 2 decided that, after some minor changes, the draft should be forwarded to ISO TC 112 to be put to a vote. This vote took place from beginning of August to early November 2017.

As a result of the vote, the ISO DTS (Draft Technical Specifications) 20175 was approved without any further comments. On the TC 112 meeting on Nov 30, 2017, it was decided to submit the DTS for publication.

The headquarter of ISO in Geneva reviewed the DTS and proposed several additional editorial corrections, which were assessed in March 2018.

ISO/TS 20175 was published in April 2018 (<https://www.iso.org/standard/67207.html>).

Objective 2 - To work with ISO TC 112 to develop a Technical Specification for procedures to measure and report outgassing rates.

To fulfil the objective, two successive versions of working drafts were developed, the first in October 2015, the second in May 2016. The first draft was discussed by the Working Group 2 (WG 2) members of "Vacuum Instrumentation" of ISO TC 112 in November 2015. The comments were considered in the succeeding working draft. This was published on the website of the project and uploaded on the Livelink website of ISO. Besides the Working Group 2, the wider community of manufacturers and users of QMS and researchers who measure outgassing rates were asked to comment by November 2016. The comments were discussed at a workshop from Jan 30 - Feb 1, 2017 and at the following WG 2 meeting on Feb 2-3, 2017. As a result of these discussions, a new draft was developed and put to vote within ISO TC 112 WG 2. The WG 2 decided that, after some minor changes, this drafts should be forwarded to ISO TC 112 to be put to a vote. This vote took place from beginning of August to early November 2017.

As a result of the vote, the two ISO DTS (Draft Technical Specifications) 20177 was approved with just a few comments. On the TC 112 meeting on Nov 30, 2017, it was decided to submit the DTS for publication with some editorial changes discussed at the meeting.

The headquarter of ISO in Geneva reviewed the DTS and proposed several additional editorial corrections, which were assessed in April 2018.

ISO/TS 20177 was published in June 2018 (<https://www.iso.org/standard/67208.html>).



Impact

After the preparation of drafts of the two Technical Specifications, the project involved the Working Group 2 "Vacuum Instrumentation" (WG 2) of ISO TC 112 to discuss the drafts and develop them further with the project partners. In a meeting of ISO TC 112 in November 2015 the business plan and schedule was harmonized with the schedule of this project. After this step, the project opened the discussion of the standards to a wider community including manufacturers and users in industry, science and metrology. This wider community was addressed via the website, the social network LinkedIn and by email contacts and invited to a workshop from Jan 30 - Feb 1, 2017. On this workshop there were intense discussions and the results were discussed at the following WG 2 meeting on Feb 2-3, 2017. After agreeing a new draft with this community, the primary supporter, ISO TC 112, used the draft for a ballot which ended in an approval of the draft. From Nov 29 to Dec 1, 2017 another ISO TC 112 meeting was held and it was decided to submit ISO DTS 20175 and 20177 to the ISO headquarter for publication.

ISO TS 20175 was published in April 2018, ISO TS 20177 in June 2018.

The Technical Specification for the characterisation and calibration of QMS will allow end users to compare the performance of QMS and use them with the best possible accuracy. A more accurate characterisation of QMS will also support their development.

The Technical Specification for outgassing rate measurements will make these measurements more reliable and comparable and therefore costly "local" solutions (used in industry to provide agreement between different suppliers of vacuum components) should become obsolete.

The two Technical Specifications which were developed in the project are important in particular for end users from the field of high energy accelerators, suppliers of EUV components and positioning devices and from the coating and semiconductor industries. The new Technical Specifications enable the users and manufacturers to reliably quantify outgassing rates. Users and suppliers can agree on established methods how to characterize QMS and measure outgassing rates which will avoid judicial conflicts.

The company ASML, which is focussed on semiconductor lithography systems by extreme ultraviolet radiation (EUV) at 13 nm, with their suppliers will incorporate the two TS in their procedures for evaluating quadrupole mass spectrometers and outgassing rates and propose the two TS to the SEMI (Semiconductor Equipment and Materials International) organisation for further consideration.

This last initiative from industry shows in which direction the results of this project will have further impact: On the basis of the Technical Specifications users and suppliers of vacuum equipment will agree on certain standards of how "clean" components for vacuum have to be in terms of outgassing rates. The community can concentrate on material development and characterisation instead of arguing about measurement methods. This standardisation will save energy and costs for the companies and due to the more efficient material development help to producible sustainable and protect the environment. The still ongoing miniaturization of all kinds of sensors, communication, semiconductor and biomedical equipment will greatly profit from the two Technical Specifications, because EUV lithography systems are made possible with clear specifications of outgassing rates.

Project start date and duration:		01 May 2015, 36 months
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