VA 1: Future Requirements on Vacuum Pumps and Vacuum Gauges

Time: Monday 10:00–12:00 Location: H6

Invited Talk VA 1.1 Mon 10:00 H6

The Birth of a New Turbo-Molecular Pump — •Martin Tollner — Oerlikon Leybold Vacuum, 50968 Cologne, Germany

From the initial market requirement specification to product launch the process of developing a new turbo-molecular pump for the vacuum market is full of complex engineering challenges. The on-going requirement to always have better performance, lower cost and improved reliability pushes engineers to continuously improve their methods of work. Striving to improve turbo-molecular pump performance requires state of the art engineering modelling tools, which in some cases are not commercially available. To maximise pumping performance, pumping mechanism modelling tools are required to accurately model and optimise a pump design for a variety of gas types across the molecular, transitional and viscous flow regimes. Also a detailed understanding of material properties as well as rotor stress simulation is required to increase performance by increasing rotational speed and blade velocities. Thermal limitations usually dictate the performance envelope of a pump, therefore the ability to accurately model and understand the thermal behaviour of a pump is the key to enhancing the performance envelope. Once the initial design concept is proven, there is a detailed series of validation, compliance and reliability testing required to ensure the product is safe and reliable before product launch. This talk aims to give an overview of the various methods, tools and processes used to develop a world class turbo molecular pump from requirement through to product launch.

VA 1.2 Mon 10:40 H6

A metal foil vacuum pump for the fuel cycle of fusion power plants — •Thomas Giegerich and Christian Day — Karlsruher Institut für Technologie (KIT), Institut für Technische Physik (ITEP), Eggenstein-Leopoldshafen, D-76344, GERMANY

At KIT Karlsruhe, a new vacuum pump based on the physical principle of superpermeation is under development. This metal foil pump shall be used in the fuel cycle of a fusion reactors and forms the central part of the Direct Internal Recycling concept (DIR), a shortcut between the machine exhaust pumping and the fuelling systems.

This vacuum pump simplifies the fusion fuel cycle dramatically and provides two major functions simultaneously: A separating and pumping function. It separates a hydrogen isotopes and impurities containing gas flow sharply into a pure H-isotopes flow that is also being compressed. The remaining impurity enriched gas flow passes the pump without being pumped.

For superpermeability, a source of molecular hydrogen is needed. This can be achieved by different methods inside of the pump. Most important are plasma based or hot rod (atomizer) based methods.

In this talk, the physical working principle and the modeling of this pump is presented and the development towards a technical separator pumping module is shown up.

Invited Talk VA 1.3 Mon 11:00 H6

Redefinition of a 60 years old barrier: simple Bayard-Alpert gauge beats the X-ray limit — Jaroslaw Iwicki, Marco Walter, Heiko Wunderlich, •Michael Flämmich, and Ute Bergner — VACOM Vakuum Komponenten & Messtechnik GmbH, Gabelsbergerstraße 9, 07749 Jena, Germany

Since the invention of the Bayard-Alpert (BA) hot cathode ionization gauge in 1950 there is a continuous trend with increasingly challenging effort to improve the lower pressure measurement limit. In this regard, several attempts with rather complex setups have been made in the past. In this contribution a standard-like BA gauge is discussed with dedicated focus to accuracy and reproducibility in the lower pressure measurement range. BA gauges deliver a minor residual current that is inherent to the design of the sensor and that defines the lower measurement limit of the gauge. An investigation of the basic physical processes that contribute to the residual currents in BA gauges yields a novel approach to minimize the residual current in BA gauges directly in the sensor while keeping the simple and established BA setup. Experimental results of a new BA gauge with a compensation of the residual current (BARION XHV) show an extended lower measurement limit by two decades down to XHV and a significantly increased accuracy in the pressure range 1E-9...1E-11 mbar. Due to a respective design, furthermore, an improved reproducibility is ensured.

VA 1.4 Mon 11:40 H6

Si-Feldemissionskathoden für Anwendungen in miniaturisierten Ionisationsvakuumsensoren — •Christoph Langer[1], Christian Prommesberger[1], Florian Dams[1], Pavel Serbun[2], Benjamin Bornmann[2], Stephan Mingels[2], Günter Müller[2] und Rupert Schreiner[1] — [1]Fakultät Mikrosystemtechnik, Hochschule Regensburg — [2]Fachgruppe Physik, Bergische Universität Wuppertal

Feldemissionselektronenquellen sind aufgrund ihrer prinzipiellen Vorteile gegenüber Glühkathoden bereits seit längerer Zeit Gegenstand der Forschung und werden bisher nur in einigen Spezialanwendungen erfolgreich eingesetzt. Hierbei werden Einzelspitzen mit Spannungen im kV-Bereich und Strömen im nA-Bereich betrieben. Dagegen werden für miniaturisierte Sensorsysteme eher Spannungen von ca. 100 V und Ströme von ca. 1 mA benötigt. Dazu wurden bisher meist Feldemissionskathoden mit CNTs vorgeschlagen, welche für Anwendungen in der Halbleiterindustrie aufgrund des Kohlenstoffanteils nicht erwünscht sind. Ziel unserer Arbeit ist es, Si-basierte Elektronenquellen zu realisieren, die mit anderen miniaturisierten Vakuumsensoren auf einem Chip integrierbar sind. Mithilfe eines optimierten Herstellungsprozesses konnten wir p-Si-Spitzenarrays mit Spitzenradien von wenigen nm realisieren [1]. Messungen an diesen Strukturen zeigen ein sehr homogenes Emissionsverhalten, das vor allem im Sättigungsbereich bei Emissionsströmen von ca. 10 nA pro Spitze zeitlich stabil (Schwankungen < 5 %) und optisch schaltbar (Faktor > 2.5) ist [2].

[1] F. Dams, IEEE Trans. Electron Devices 59 (10), 2832-2837 (2012)
[2] P. Serbun, J. Vac. Sci. Technol. B 31 (2), 02B101 (2013)