VST-03-1-I-TU

Monte Carlo simulation to determine the sticking probability of SAES ZAO® sintered non evaporable getter disk

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Sintered Non Evaporable Getter (NEG) material is widely used in particle accelerators, synchrotron light sources and other research and industrial applications to pump vacuum systems to low pressure level. The advantage of sintered NEG material is that it provides pumping performance with no mechanical movement; it is oil- and particle-free, easy to regenerate, and associated with low operation cost. Recently, SAES Getters has developed a new sintered NEG material ZAO® which has demonstrated pumping performance for protium and deuterium much better than usual sintered NEG materials available in the past. This may open the door to applications in nuclear fusion. One idea is to use thousands of sintered ZAO disks to pump the neutral beam injection (NBI) system of the fusion reactor, where a high gas load should be coped with. One independent experiment was launched by the Vacuum Department of the Institute of Technical Physics of the Karlsruhe Institute of Technology (KIT) to check the pumping speed and the pumping capacity of this new material under different conditions.

In this paper we will mainly present the numerical simulation of both NEG disk experimental setups in KIT and in SAES. The experimental setup in KIT is based on the Fischer-Mommsen-Concept with a dosing dome and a pumping dome connected by a known conductance, and focusing at the performance evolution along with the pumping capacity. The experimental setup in SAES is similar, also based on the known conductance. The upstream pressure is kept as a constant in SAES experiment, whereas the mass flow rate is kept as a constant in KIT experiment. In both experiments the downstream pressure is used to calculate the pumping speed of the ZAO sintered disk. KIT was using the Test Particle Monte Carlo (TPMC) code ProVac3D based on the ansatz that the local density is proportional to the total time-of-flight of the molecules, whereas the SAES setup was simulated with the AVOCADO code which is basically a ray-tracing code that determines view factors. Both codes have been fully validated in the past. Since the pressure gradient moving towards the getter disk is such that the pressure measured at the gauge cannot be used to directly calculate the sticking coefficient, numerical simulation is needed to calculate the pressure at the gauge as a function of a given sticking coefficient in the simulation. In this way, the actual sticking coefficient can be inversely derived. Furthermore, both sides of the ZAO disk cannot pump with identical performance due to geometrical constraints present in both the SAES and KIT experiments, and this factor is evident in the simulations. By fitting the experimental data, achieved in two different setups, with the simulation results, obtained with two different validated codes, the sticking probability of the ZAO sintered disk and its evolution along the load cycle can be derived. This very important parameter is required in order to proceed with the following step of the project: the design of a future pumping system with thousands of ZAO sintered disks.