Measurement of Low Vapor Pressures Employing the Knudsen Effusion Technique and a Magnetic Suspension Balance

Ricarda Kendler [C, S]
Chair of Particle Technology, Ruhr-University Bochum, Bochum, NRW, Germany
kendler@fvt.rub.de

Frieder Dreisbach and Reza Seif
TA Instruments, Bochum, NRW, Germany

Stefan Pollak and Marcus Petermann
Chair of Particle Technology, Ruhr-University Bochum, Bochum, NRW, Germany

The choice of method for measuring vapor pressures of pure substances is dependent on the order of magnitude of vapor pressure. For a substance with high vapor pressure, a different method has to be applied than for a substance with low vapor pressure. To account for a wide range of pressure, a modular measuring system was developed, which is based on a magnetic suspension balance (MSB). Each module uses a different measurement principle and is applicable to a different range of vapor pressure. The here-presented module is based on the Knudsen effusion technique and is applicable to low vapor pressures (< 1 Pa). A sample is placed in a Knudsen cell wherein the gas phase of the sample is in equilibrium with its condensed phase. Some gas molecules effuse through a small orifice in the lid of the cell into a high vacuum environment, where the probability of a molecule hitting the orifice is directly linked to the vapor pressure. A cooled condensation plate, connected to a MSB, is located directly above the effusion orifice. The effused vapor strikes the plate, where it condenses. The increase in mass of the plate is continuously measured by the MSB. From the amount of the effused vapor in a certain time, the vapor pressure can be calculated. The condensation plate has a dished shape, so that the whole hemisphere above the effusion orifice is covered. By this means, all effused vapor is collected and the vacuum chamber is not contaminated. Furthermore, a measurement of all effused mass is possible. The MSB allows long-term measurements with high precision. The relative combined expanded uncertainty (P = 95.5 %) for vapor pressure measurements is estimated to be 1 %. The new apparatus is validated with benzoic acid as test substance.