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Properties and surface interaction of a low pressure microwave microplasma as an electron source for a MEMS device miniature mass spectrometer

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Micro-electromechanical systems (MEMS) have a broad area of application in modern technology. Lab-on-a-chip devices are enabled by the shrinkage of sensors to micrometer scale.
The authors present a micro-fabricated mass spectrometer equipped with a low pressure plasma source driven at a frequency of 2.45 GHz. An antenna creates a cylindrically-shaped plasma volume of 250 µm in radius and 300 µm in height, surrounded by borosilicate glass and electrically conducting silicon. The low pressure microplasma is used as an electron source for electron impact ionization and therefore electron density, power efficiency and gas consumption are key parameters for optimization. Limited availability of inert materials in MEMS processing technology requires careful plasma process design. Change of surface composition by plasma etching, film deposition or ion induced sputtering degrades device properties over time.
Absolutely calibrated, space- and time-averaged optical emission spectroscopy (OES) is used to measure gas temperature, electron temperature and electron density in noble gas atmosphere with small additions of nitrogen. Space-resolved spectral line analysis is performed by means of a CCD-Camera equipped with a bandpass interference filter. The pressure inside the discharge chamber is estimated by the pressure drop induced by micro-capillaries. Surface changes over long periods of operation time are measured by SEM, EDS and XPS analysis and correlated with mass spectrometer measuring signals.

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