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P4.3011 RF power transfer efficiency of low pressure ICPs in light molecular gases

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Inductively coupled plasmas (ICPs) are a widespread and versatile radio frequency (RF) driven plasma generation technique. Thus, significant efforts have been made to optimize them according to the individual requirements at hand. The analysis of the RF power transfer efficiency - or analogously of the plasma equivalent resistance - has been of particular interest. Both quantities describe the power absorption by the plasma, since not all of the delivered RF power is necessarily coupled to the plasma itself. Even if an ideal match between the generator and the load is achieved, substantial transmission losses can occur, originating e.g. from ohmic heating of the coil and the RF network. Most of the fundamental investigations of the RF power transfer in low pressure ICPs and its dependence on pressure, power or excitation frequency have been conducted in noble gas discharges, whereas light molecular gases such as hydrogen or deuterium are scarcely treated. However, the multitude of additional processes in molecular discharges such as ro-vibrational excitation or dissociation can have a distinct impact on the plasma parameters which determine the power transfer. Thus, the transferability of results obtained in noble gases to molecular discharges is not necessarily provided without limitation.
Accordingly, experimental investigations of the RF power transfer efficiency of low pressure H_2/D_2 ICPs in a broad parameter range are presented and compared to corresponding results obtained in noble gases. The studies are conducted at a cylindrical setup in the pressure range between 0.3 and 10 Pa and for different excitation frequencies between 1 and 4 MHz at RF powers up to 1 kW. By applying a subtractive method which quantifies the transmission losses within the plasma coil and the RF network, the RF power transfer efficiency is determined. The key plasma parameters of the discharges are measured via optical emission spectroscopy and a double probe, which allows to discuss the obtained power transfer efficiency against the background of electron heating and the influence of atoms in molecular discharges.

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