GEC10-2010-000394

Abstract for an Invited Paper
for the GEC10 Meeting of
the American Physical Society

The Multipole Resonance Probe – Concept, Theory, Experiments[1]

RALF PETER BRINKMANN, Ruhr-University Bochum

Plasma diagnostics is a highly developed science. Of the many available techniques, however, only few are suitable for an industrial setting. To be useful for the supervision or control of technical plasmas, a diagnostic must be i) robust and stable, ii) insensitive against perturbation by the process, iii) itself not perturbing to the process, iv) clearly and easily interpretable without the need of calibration, v) compliant with the requirements of process integration, and, last not least, vi) economical in terms of investment, footprint, and maintenance. Plasma resonance spectroscopy – exploiting the natural ability of a plasma to resonate on or near the electron plasma frequency – is believed to provide a good basis for such an "industry compatible" plasma diagnostics. The idea is time-honored but has found renewed interest in recent years: An electric probe is used to feed a high frequency signal into the plasma and the response is evaluated with the help of a mathematical model. Once ω_{pe} is known, one can calculate the electron density as $n_{\mathrm{pe}} = \omega_{\mathrm{pe}}^2 \epsilon_0 m_{\mathrm{e}}/e^2 = 1.24 f_{\mathrm{GHz}}^2 \times 10^{10} \mathrm{cm}^{-3}$. The contribution will describe the general idea of active plasma resonance spectroscopy and introduce a mathematical formalism for its analysis. It will then focus on a novel realization, the so-called multipole resonance probe MRP, where the excited resonances can be mathematically classified and the connection between the probe response and the desired electron density can be evaluated analytically. The current state of the MRP project will be described, including the outcome results of first experiments.

[1]Support by the Deutsche Forschungsgemeinschaft (DFG) via the Graduiertenkolleg GK 1051 and the Ruhr-University Research School and by the Federal Ministry of Education and Research in the frame of the project PLUTO is gratefully acknowledged.