Accurate rf Discharge Characterization and Influence of Reactor System Design on the Microscopic Plasma Parameters

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Plasma processing is widely used in various applications covering the deposition of thin films, surface modification, dry etching e.t.c. Although good progress has been done in the last decades in all these processes there are still open issues concerning especially the design of plasma apparatus and the effective control of plasma parameters. A good part of these issues is related to the electrical characterisation of the chamber and the subsequent measurement of the real power consumption during the process. This leads to discrepancies in the experimental results between different labs around the world which hinders the transfer of knowledge and in many cases in poor repeatability. Moreover, in most of the cases plasma reactors and associated equipment are not optimally designed for the specific process and this may result in significant economic and environmental problems. The aim of this work is to point out significant externally measured plasma parameters that could ease design, control and transferability of plasma conditions. The results presented are based on the application of several electric and optical plasma diagnostics that complement the application of Fourier Transform Plasma Power and Impedance Analysis that is applied in completely characterized plasma reactors for the determination of the rf power actually consumed in the discharge. The discussion includes the influence of different parts like the rf electrode design, the external rf circuitry and the specific process conditions on the microscopic characteristics of the plasma, including potential and field distribution, electron density and energy and power dissipation paths, as well as on the accuracy and repeatability of power determination. It is revealed that rf power consumption, even when it is accurately measured like in the present study, is not sufficient for the characterization and transfer of discharge conditions. Conclusions are drawn towards optimum plasma chamber design and external circuitry.

Keywords
rf power
plasma diagnostics
rf design