【총회초청】

Experimental Study of an rf antenna immersed in a helicon plasma

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A traditional Helicon source with a classical double saddle field antenna, has been modified by introducing a second smaller copper antenna into the plasma having the same RF frequency of 13.56 MHz as the main Helicon antenna. While the Helicon antenna is shielded from the plasma by a quartz tube, the second antenna is directly exposed to the plasma and behaves somewhat like a biased substrate in an inductive (or TCP) plasma processing reactor. It is also a situation commonly met in fusion plasmastudies where the antenna for ion cyclotron heating (for example) is in contact with the plasma. Dramatic changes in all plasma parameters were measured as a function of time with the density decreasing, the electron temperature increasing, the plasma potential increasing and the self bias on the immersed antenna considerably increasing. The cause was eventually discovered to be a thin copper film on the inside of the glass source which acted as a faraday shield for the main plasma producing heliconantenna. The copper was sputtered from the immersed antenna and depositedas a thin film on the rf feedthroughs and the rest of the source, which decreased in thickness as the distance from the antenna increased. The effective faraday shield so created decreased the coupling to the plasma which decreased the density to below the capacitive to inductive coupling transition at which point the electron temperature increased. Careful measurements as a function of time for different powers on the helicon and small antenna showed that for sufficiently high helicon powers, there issufficient sputtering induced by the voltage on the helicon antenna that a copper free path is left in the glass close to the helicon antenna which allows the helicon antenna to continue to function normally in spite of the continued sputtering of the immersed antenna. This RF current carrying antenna is DC isolated by a 10 nF capacitor placed between the generator and the matchingbox, allowing a DC self-bias to form on the antenna. As the potential difference between this antenna and the plasma is greater than the sputtering threshold for copper, the immersed antenna gives rise to sputtering. The effect of sputtering from the antenna and the resulting deposition onto the source walls has been studied. It was found that the copper deposited on the source tube act asa Faraday shield for the Helicon antenna, reducing the plasma density and pushes the transition from capacitive to inductive mode to higher and higher powers as the deposited copper layer grows. It has also been shown that this plasma drift only occurs for certain conditions which mainly depends on the power on the Helicon antenna due tochanges in the DC voltage at the walls close to (the high voltage side of) the Helicon antenna when the RF power is changed. Hence giving rise to re-sputtering of the deposited copper at higher powers on the Helicon antenna.