Spatio-temporal Behavior of Microwave sheath-Voltage combination Plasma Source

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Microwave sheath-Voltage combination Plasma (MVP) is a high density plasma source and can be used as a suitable plasma processing device (e.g., ionized physical vapor deposition). In the present report, the spatio-temporal behavior of an argon MVP sustained along a direct-current biased Ti rod is investigated. Two plasma modes are observed, one is an "oxidized state" (OS) at the early time of the microwave plasma [1] and the other is "ionized sputter state" (ISS) at the later times. Transition of the plasma from OS to ISS, results a prominent change in the visible color of the plasma (Fig. 1), resulting from a significant increase in the plasma density (Fig. 2), as measured by a Langmuir probe. In the OS, plasma is dominated by Ar ions and the density is in amplitude order of 10^{11} cm^{-3}. In the ISS, metal ions from the Ti rod contribute significantly to the ion composition and higher density plasma (10^{12} cm^{-3}) is produced. Nearly uniform high density plasma along the length of the Ti rod is produced at very low input microwave powers (around 30 W). Optical emission spectroscopy measurements confirm the presence of sputtered Ti ions and Ti neutrals in the ISS (Fig. 3).

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References

[1] S. Kar, L. Alberts and H. Kousaka, *AIP Advances* **5** (2015) 017104.

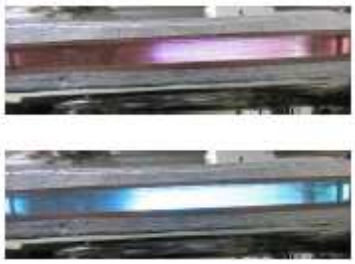

Fig. 1. Color changing from OS to ISS. The antenna starts from right side.

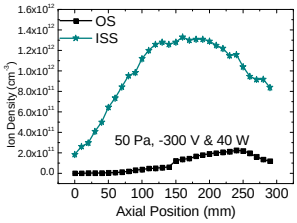

Fig. 2. Ion density distribution for OS to ISS. Measurements are taken from left side.

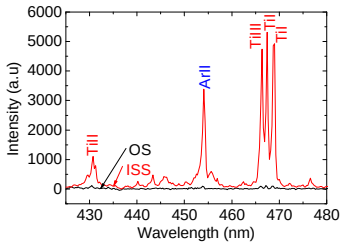

Fig. 3. Emission intensity for OS to ISS.