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Blue core phenomena in nonuniform helicon plasma

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Helicon plasma source can generate plasma with high density (10^{17} m^{-3} ~ 10^{20} m^{-3}), high ionization ratio (~ tens of percentages) and higher power efficiency compared to standard inductively coupled plasma (ICP). It has been applied in many fields such as semiconductor manufacturing, space thruster and plasma surface treatment.

Blue core is the central region in helicon plasma associated with strong blue light. The plasma density and ionization ratio in the blue core region is considerably higher. Blue core was also regarded as a new transition mode after the traditional wave mode (W - mode) [1]. However, most of these experiments still produced blue core under constant pressure and uniform magnetic field.

This work designed three different types of nonuniform magnetic field configurations for the generation of helicon plasma [2]. It showed that Ar plasma discharge can enter into the wave mode (W-mode) at about 200 W under three different types of magnetic field structures. Blue core phenomenon appeared at 450 W. The radial distribution of the plasma under high power was dark in the middle and bright at the edge. It was found that the plasma density was always high in the middle and low in both sides.

Meanwhile, the radial distribution of plasma density and electron temperature were different under three designed gas pressures [3]. The plasma density peak and electron temperature peak still maintained the on-axis under 0.08 Pa. However, the plasma density peak was at the on-axis and electron temperature peaks were at the off-axis under other pressures. It meant the heating mechanism changed from central heating to edge heating. It can be proved that the enhancement of skin effect and TG wave made more energy transfer to the edges as increasing the gas pressure.

Figure 1 illustrates the plasma density maintains the on-axis peak, and the peak of electron temperature profile is evolved from on-axis into off-axis due to skin effect with the increased power. This work is supported by Beijing Municipal Natural Science Foundation (No. 1192008).

References

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[3] C.W. Wang *et al*. Plasma Sci. Technol. **28**, 123519 (2021)

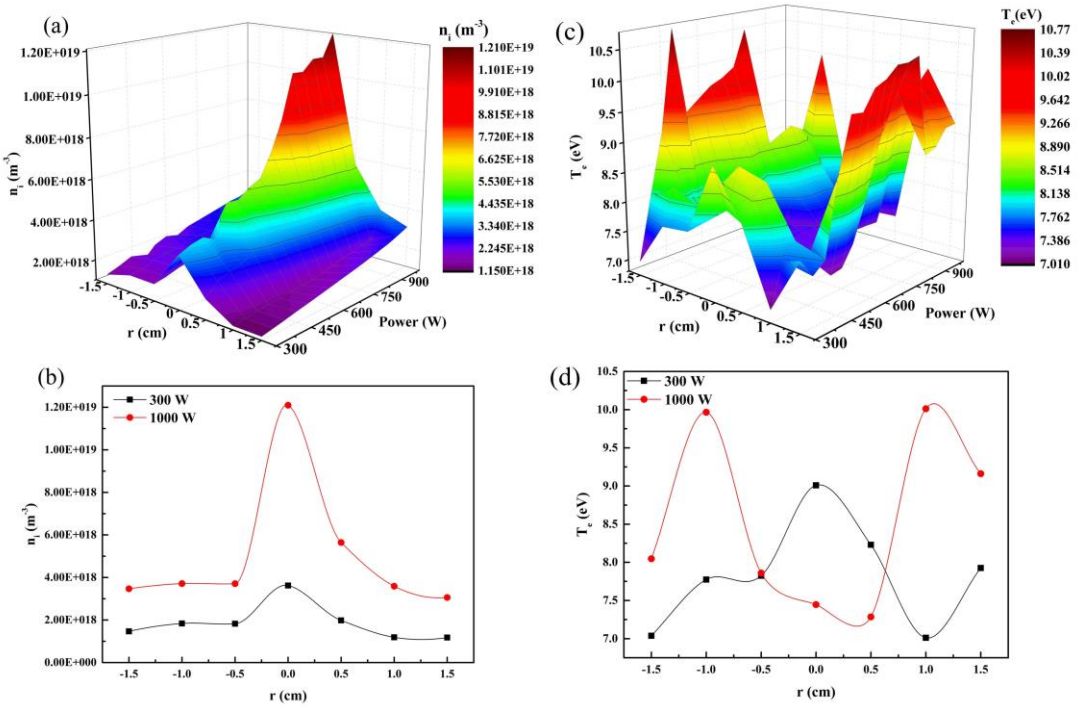

Figure 1 Three-dimensional contour plot and two-dimensional curve of radial n_i distribution (a, c) and electron temperature T_e (b, d).