Experimental study of sheath heat transmission factors by thermocouples and triple probe in DiPS-2

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Accurate prediction of heat flux is important because the lifetime of fusion reactor could be determined by the damage of various PFC's due to the high heat flux. The measurement of heat flux relies on determination of sheath heat transmission factor (γ_s). Besides infrared measurement, thermocouple have provided reliable data for heat flux measurements [1, 2].
Plasma was generated in a linear device, called Divertor Plasma Simulator-2 (DiPS-2), with the following conditions: plasma density (n_e) ~ 10^{17} cm^{-3} and electron temperature (T_e) ~ 1 - 15 eV with argon, where plasma is flowing into a chamber, called DiSC (Dust interaction with Surfaces Chamber). Thermocouples and a triple probe were used to measure the heat flux toward the tungsten target in DiSC, which was operated with discharge current = 10 – 40 A, plasma density (n_e) ~ 10^{16} – 10^{17} cm^{-3} and electron temperature (T_e) ~ 1 – 15 eV. Based upon a simple sheath theory, a theoretical sheath heat transmission coefficient can be estimated as approximately 6-7 in pure argon plasma [3, 4]. To deduce the sheath heat transmission factor experimentally, three thermocouples were embedded directly into the tungsten target with thickness of 20 mm. Each thermocouple is located at 18 mm, 13 mm, and 3 mm from target surface, respectively. Theoretical heat flux estimated at DiSC center is about 30.76 kW/m^2. Heat flux have been deduced by thermocouples in utilizing a simple heat conduction equation, $q_{TC} = -k(T_1 - T_0)/(x_1 - x_0)$, where T, x are thermocouple temperature and position of thermocouple. Triple probe measured the electron temperature and ion saturation current. From these measurements, sheath heat transmission factor is obtained from $\gamma_s = q_{TC}/kT_e\Gamma$. Experimental values of sheath heat transmission factors in argon plasma have been compared with theoretical values. To expand the case of pure plasma to the impure plasma, we have generated He + Ar/N_2 plasmas. By varying the pressure ratio of additional gas (Ar, N_2), effect of impurity in sheath heat transmission factor was also investigated.

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