§18. Formation Mechanism and Transport of Dust Particles in the Divertor Plasmas

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Dust particles collected in magnetically confined fusion devices have many significant effects on a fusion reactor, such as tritium retention, impurity release, degradation of vacuum sealing and electrical isolation, etc. Since the dust particles collected on the first walls of fusion devices are formed by series of different plasma shots, it is not easy to clarify the fundamental processes of the dust formation mechanism in the fusion plasmas. So far, laboratory scale experiments using a high density divertor simulator with DC discharges[1], DC glow plasmas and so on, mainly contribute to experimental studies on the basic mechanism of dust formation.

In the present experimental study high power inductively coupled plasmas(ICPs) with a power level of 10~20 kW are used to study plasma-material surface interactions and dust formation mechanism. High pressure ICPs have characteristic features, such as high density(10^{19}~10^{21} m^{-3}), high heat flux(~1 MW/m^2), flexible working gas mixtures and so on. These plasma features are very helpful to study the material erosion, redeposition and dust formation, comparing with other laboratory experiments with different plasma parameter ranges. Here initial results from the experiments of argon or argon-hydrogen mixture plasma irradiation onto graphite targets are reported. The electron temperature and density of the plasmas near the target are ~1 eV and ~$10^{19}m^{-3}$, respectively. Since the surface temperature of the graphite targets are 1300~1600 K and the incident energy of ion and neutral particles is below 10 eV, dominant processes of graphite target erosion should be radiation enhanced sublimation(RES) and chemical sputtering in our experiment. Figure 1 shows a picture of Ar plasma irradiation experiment. The target is placed at downstream region

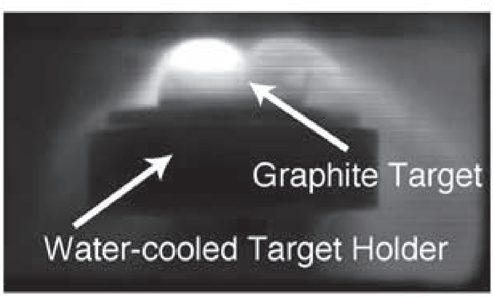

Fig. 1 Picture of Ar plasma irradiation onto graphite Target

~250 mm away from the core plasmas and is inclined to measure the surface temperature by radiation thermometer. In Figs 2(a)~(d) surface modification of graphite target in different irradiation condition are shown. Just a 30 minutes plasma irradiation changes the surface morphology strongly as shown in Fig. 2. In the present preliminary experiments graphite targets are mainly eroded not deposited by plasma irradiation of Ar and Ar+H_2, but small dusts of ~1 mm size are observed in Ar+H_2 plasma(Figs. 2(c), (d)). Now we are constructing a new ICP device for plasma irradiation experiments and new results will be shown soon.

In parallel to experimental study on dust properties we are carrying out computer simulations on dust transport in the divertor plasmas[2] using DUSTT code. In Fig. 3 typical results of dust particle transport in DIII-D are shown. Detailed analysis will be shown elsewhere.

References

[1]Ohno. N., Kobayashi, Y., et al., J. Nucl. Mater., **337**-**339**, (2005)35.

[2]Krasheninnikov, S. I., Soboleva, T. K., et al., J. Nucl. Mater., **337**-**339**, (2005)65

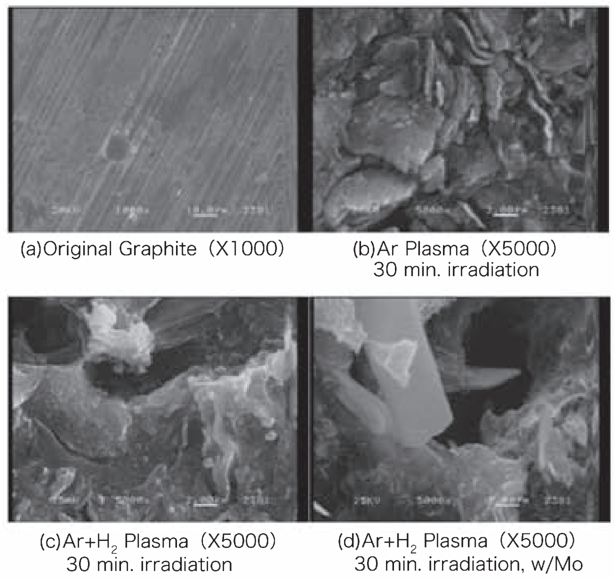

Fig. 2 SEM pictures of graphite target of different plasma irradiation condition.

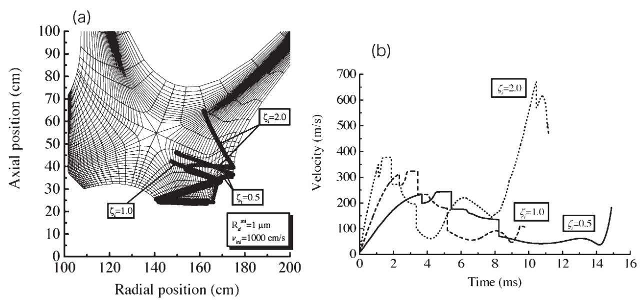

Fig. 3 DUSTT simulation results, trajectories of carbon dust(a) and dust velosity changes(b).