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Development of Tungsten Injection System for Impurity Accumulation Study in KSTAR Plasma

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The International Thermonuclear Experiment Reactor (ITER) baseline strategy is likely to employ a full tungsten (W) divertor from the non-active phase, therefore high Z impurity transport studies are important for fusion plasmas. In Korea Superconducting Tokamak Advanced Research (KSTAR), a simple W injection system and Vacuum UltraViolet (VUV) spectroscopy have been developed for the high Z impurity transport study. The VUV prototype system for ITER [1] has been installed in KSTAR. In this paper, we describe the current development status of the W injection system in KSTAR.

Figure 1 shows the schematic view of the W injection system for KSTAR. This system consists of an injection gun, a trigger, a piezoelectric motor, and particle storage. The diameter and length of the injection gun are 8 mm and 50 mm, respectively. The piezoelectric motor has been chosen for moving the trigger under the strong magnetic field. This system will be mounted on the midplane manipulator installed at D-port. Since the manipulator moves horizontally to a location inside the vacuum vessel around 10 cm away from the last closed flux surface, the required flight-distance is more than 10 cm from the injection gun. The other requirements are as follows: (1) a compact size, (2) the tolerance for strong magnetic fields and high-vacuum environments, (3) a reloadable system, and (4) the capability to inject a small amount of metal particles.

We have tested the W injection system with copper (Cu) particles, whose diameter and length are 0.5 mm and 1-2 mm, respectively. Figure 2 shows the experimental setup. The test was performed at atmospheric pressure. Copper particles are ejected 6 times and 20 mg of Cu was launched at each time. The target plate is set on 100 mm away from the ejected point (x=0 mm in Fig. 2). Figure 3 shows the distribution of launched Cu particles on the target plate. The central axis in Fig. 2 was defined as (y,z)=(0,0) in Fig. 3. In this experiment, about 80 % of the total ejected Cu particles have reached to the target plate. The Cu particles on the target plate are mostly distributed in the range of $-10<y<10$ and $-30<z<0$ (mm). The averaged drop, which is the distance from the central axis along the z-axis (see the blue circle in Fig. 3), is about 13 mm. It is acceptable for injecting them into the KSTAR plasma. The launched velocities at the ejected point are estimated about 0.2 m/s for this case, ignoring air resistance.

In this paper, the dependence of particle sizes on flight-distance and a test with W particles will be also presented.

References:
[1] C.R. Seon *et al.*, Rev. Sci. Instrum., **81** (2010) 10E508.

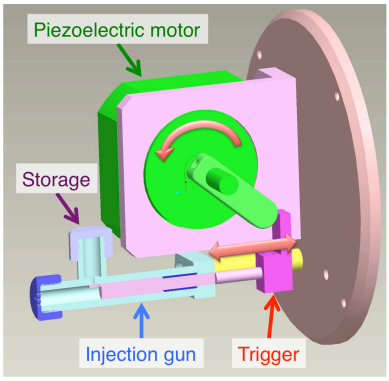

Figure1. Schematic view of tungsten injection system

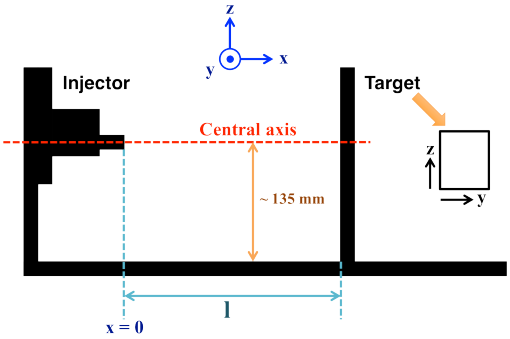

Figure2. Schematic view of experimental setup

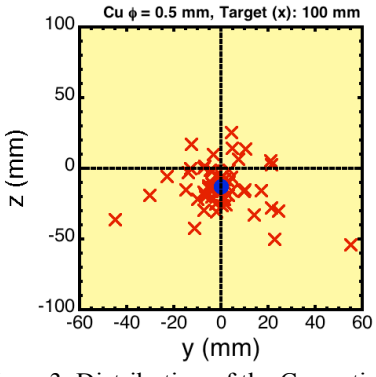

Figure3. Distribution of the Cu particles on the target plate.