§21. Neon Pellet Formation Using Ice Pellet Injector

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Materials of an impurity pellet for plasma experiments were often chosen among those which are solid at room temperature. One reason is in their easy treatment. Recently, however, requests for an iced impurity pellet injection are increased, for example, neon as so called the killer pellet. Techniques of the ice pellet injection of normal deuteron/hydrogen are well established, and there are a variety of injectors in the world. In principle, using these hydrogen pellet injector one can produce any iced impurity pellet, only by setting the thermostat temperature lower than the triple points of impurity materials. Unfortunately, however, the lack of variety of cooling material, that is, we can use only liquid helium and liquid nitrogen, makes it difficult to keep temperature at required points. In addition, trials of iced pellet formation with mixed gasses so for were not successful, becuse of the large difference in the freezing point of each material.

We tried to produce neon pellets using normal ice pellet injector, and injected them to CHS. The pellet injector is of the pneumatic single shot type. The pellet is formed into the cylindrical shape with the diameter of 1.3 mm and the length of 1.0 mm. Gas pressure for pellet formation can be increased up to 1.3 atm. The acceleration gas pressure is operated in the range of 10 - 15 atm. All these gas pressures are measured outside the injector at the room temperature by using Baratron. The cooling system was optimized for hydrogen pellet formation. The tripple point of neon is 24.5 K, that is enough higher than the liquid helium temperature. This injector has neither liquid helium nor neitrogen container, and has only liquid helium floating system as a cooler. The floating rate is related to the reached temaparature.

Keeping the cryostat at different higher temperatures in the range of 5 - 25 K, we tried to produce pure neon pellet. In each case, only at the first shot just after neon gas was filled, we could get one neon pellet. After this shot, no ice was produced in the pellet lot. It was supposed that neon gas was frozen in the early stage of the gas inlet inside the injector, and could not reach the ice forming plate.

Next we tried to make neon mixed iced pellet. We prepared the mixed H_2-Ne gas with the different neon concentration; 10% and 2 %. In addition, by using gas reservor we changed the gas mixing ratio. We measure the partial pressure at gas mixture tank, outside the injector at the room temperature. We tried to produce pellet with concentration rates of 50%, 30%, 20%, 10% and 2%. In each case, the same phenomena as the case of pure neon were observed. We tested lower concentration rate, mixing 2% H_2-Ne gas and pure H_2 gas. To know the accurate concentration of neon in the iced pellets, we injected those mixed pellets to CHS during plasma discharge(Fig.1). In Fig.2, we show the neon mixed rate vs. actual mixed rate in ice, measured by the mass analyzer settled to the CHS.

Another trial we did was the exchange the order of gas flows. At the same mixed rate, in the case that we flowed neon gas first priory to hydrogen, frozen trouble mentioned above happened more often. While when we first flowed hydrogen gas into the cryostat and then added neon gas, we could get better pellets than former trials. This suggests the effect of the wall adsorption of the gas in the transfer tubes at low temperature, coming from difference of the triple temperatures.

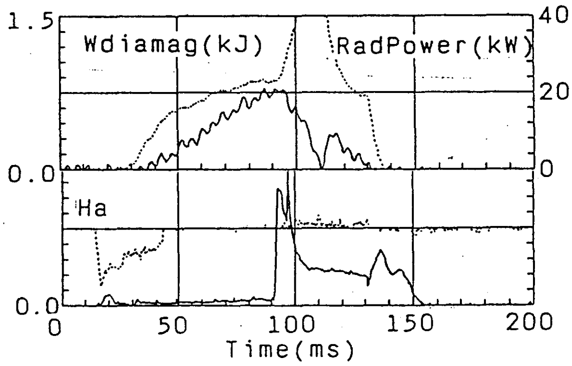

FIg.1 Typical neon pellet discharge.

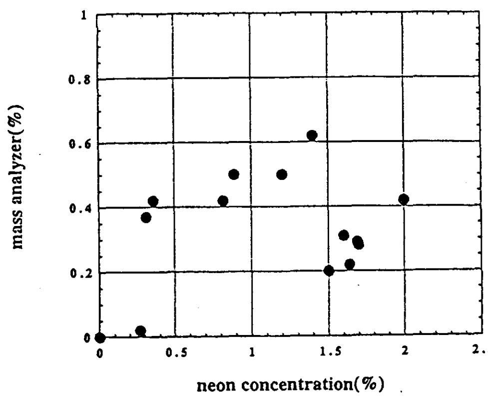

Fig.2 Neon mixed ratio in hydrogen iced pellet measured by the mass analyzer of CHS.