§12. A New Tracer-encapsulated Pellet Injector for Plasma Diagnostics

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A new injector for making solid hydrogen pellets around impurity cores has been developed for plasma transport study in Large Helical Device. A new technique has been employed for automatic loading carbon or polystyrene cores of 0.2 mm diameter from a gun magazine to a light-gas gun barrel. The injector is equipped with a cryorefrigerator and is able to form a 3.2 mm long and 3 mm diameter cylindrical solid hydrogen pellet at 7-8 K with an impurity core in its center within 6 minutes and to inject it in the light-gas gun up to 1 km/s.

The sequence of tracer-encapsulated pellet formation is represented in Fig. 1. In a gun magazine, every impurity core is placed in a separate cell. A small amount of hydrogen gas is slowly admitted into the barrel and condensed on the walls of a pellet former creating a solid hydrogen shell, which is cooled to 8-9 K. The needle comes down and is preset under the cell with the next core to be loaded. The gas flow blows through the magazine cell and pushes the core out of it. Because the whole gas flow is sucked off through the needle and the formed shell closed a channel through which the needle can enter the barrel, the core fallen out of the magazine cell hits the top of the needle, trying to get inside of it together with the gas flow Fig.1(b). However, the needle diameter is so chosen, that the core could not get through it, but close the hole in the needle like a gag. The temperature of the pellet former is increased to 30 K and the hydrogen shell is evaporated being opened the channel into the barrel. A weak gas flow leaks through untight sealing of the needle hole to hold the core on the needle top during its upward movement Fig.1(c). The pellet former is cooled to 9K once more; at the time of hydrogen inflow, it condenses on the pellet former walls, gradually filling up the whole of its cross-section Fig.1(d) and even getting inside the needle. The needle is pulled out of the pellet back to the relatively warm magazine, leaving the core and an empty channel inside Fig.1(e), and hydrogen, condensed in the top of the needle, sublimates from the needle and recondenses again in the channel formed by the extracted needle, filling it and completing the pellet formation as shown in Fig.1(f). Thus, the needle is used as a vacuum tweezers to capture and hold up a core and as a source of hydrogen to complete the pellet formation. The pellet, formed around the impurity core, is located exactly in the injector barrel. It can be observed through the barrel duct subject to suitable illumination and availability of an optical system with long-focus lens. Photos of the needle positioning and its movement according the above process are shown in Fig.2.

![Fig. 1. The sequence of operations for pellet formation around an impurity core.](image1)

![Fig. 2. Photos of the needle positioning and its movement control into the solid hydrogen watched through the quartz window.](image2)

References