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A horizontal powder injector for W7-X

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Injection of low-Z powders into fusion plasma has been used to improve wall conditions, similar to the standard boronization process using diborane. Powder injection has the advantage of being much simpler, non-toxic, and efficient. The W7-X stellarator is planning on utilizing powder injection in long pulse discharges; a proof-of-principle test for horizontal injection into the plasma was conceived. A design concept is developed using a polyetheretherketone (PEEK) paddle wheel that is driven by a piezo motor, due to the high magnetic fields, that rotates at 100 deg/s. This small unit (“flinger”) fits into an envelope of 120 mm diameter x 150 mm long, a standard size for Multi-Purpose Manipulator. The device is housed in a carbon cup mounted on a retractable probe that can be placed near the plasma edge, enabling powder injection ~4-8 cm radially into the boundary plasma. The feed for the paddle is via piezo electric actuator that vibrates a funnel filled with powder into a trough for the paddle to push. The 8 paddle arms, 35 mm long and 10 mm wide, are made from 0.38 mm thick PEEK which drag slightly along the powder-filled trough bottom, becoming a spring-loaded paddle which accelerates the powder upon release. Design challenges are the high ambient magnetic field, vacuum compatible materials, high temperature environment, limited rotary-drive options, and compact space. The design and testing of this new device will be presented.

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