Liquid Metals as Plasma Facing Components in a Fusion Reactor

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The selection of plasma facing materials (PFM) for a future Fusion Reactor has to face very important challenges. While plasma purity control calls for the use of low Z materials, the higher erosion behavior of these materials compared to that of refractory metals, for example, may preclude their use. In a Fusion Reactor, one of the key elements for which little or no information is available at present are the effects of a high dose of fusion neutrons at 14 MeV on the structural properties of the materials surrounding the plasma. This, combined with the proven deleterious effects of huge, repetitive transient heat loads expected by the fast expulsion of energy and particles from the plasma (mostly in the form of the so-called Type I ELMs) makes it unlikely a solid material solution for the PFM challenge.

Liquid materials offer very attractive properties from the conceptual point of view. First, a healing effect of any kind of plasma-induced damage is to be expected from the standpoint of fluid mechanics. Second, as they can be forced to flow away from the hot area, they are prone to the development of fast heat and particle removal concepts. Among the possible options, lithium has received most of the attention so far. Thus, the APEX and ALPS projects in the USA aimed at the design of a Fusion Reactor based on the lithium curtain concept. More recently, ideas aimed at precluding the possible effect of Lorentz forces on the stability of a liquid metal layer under the presence of strong magnetic fields were put forward and experimentally demonstrated. A conspicuous example of these concepts is the Capillary Porous System, developed at the RF and widely used nowadays in limiters and divertor fusion devices.

One of the main concerns about using lithium as a PFM in Fusion is its strong affinity with hydrogen isotopes, which can lead to unacceptable levels of tritium inventory in a reactor. This possible drawback has triggered the search of other alternatives, still encompassed into the liquid metal concept. Thus, gallium, tin, aluminum and some of their alloys with lithium are at present being considered as a possible way out.

In this presentation a review of the state of the art on the potential of liquid metals for their application to a Fusion Reactor will be given.

Keywords: PLasma Facing Components, Liquid Metals, DEMO

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