THE INTERACTION BETWEEN MATERIALS AND LITHIUM-BASED BREEDERS FOR FUSION POWER PLANTS

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Fusion is the Holy Grail for a abundant and sustainable energy source. Most of the envisioned designs employ a deuterium-tritium mix fuel (D + T) since it requires the minimum energy to achieve ignition. For this reason, tritium breeding strategies will constitute a key turning point to achieve the sustainability of nuclear fusion as commercial technology given that the availability of this element in nature is extremely limited. In ITER and DEMO designs, the Breeding Blanket (BB) is the part of the plant specifically engineered for this purpose. In other designs like ARC and CFETR similar strategies are considered to self-produce tritium in the power plant. In many proposed designs, lithium is involved as main breeding element since through the Li(n;α)T reaction it interacts with neutrons generated by nuclear fusion reactions giving T and He as product. Issues arise when structural materials are in contact with lithium-based eutectic metals or salts, due to the high reactivity of Li. In recent years we developed an amorphous alumina permeation and corrosion barrier coating which can be applied to any kind of steel at low temperature. This coating shows unprecedented mechanical and barrier properties not only in PbLi but also in other nuclear fission relevant environments. However, thermodynamical analysis suggests that binary ceramic materials suffer from oxidation-reduction corrosion which results in the formation of ternary compounds with Li. In fact, a LiAlOx layer is found on the surface (50-150 nm thick) after long-term (up to 7000 hours) exposure tests in Pb-Li. In order to fully evaluate the extension of Li penetration into the coating, a variety of techniques have been employed: TEM, APT, ToF-SIMS and XPS. We will discuss the preliminary findings of this study and discuss the implications for the future of nuclear fusion technologies.

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