Conceptual Design of a Tritium Breeding Blanket based on Nanostructured Lithium Ceramics

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One of the main challenges of fusion power plants is the self-sufficiency of its own fuel consumption. To fulfill such a requirement the power plants rely on breeding blankets with a high lithium content that use fusion neutrons for tritium production by means of n-lithium reactions. Other functions of the blanket are extraction of thermal power and shielding against radiation. Several concepts have been developed by different groups around the world. In this work, we focus on a laser fusion pre-comercial power plant defined in the framework of the European project HiPER. We have designed a breeding blanket based on nanostructured lithium ceramics. Ceramic materials like lithium titanate (Li2TiO3) exhibit well known advantages with good performance. In terms of tritium release, moisture sensitivity, and activation, and it also has a reasonable atom density and a good compatibility with structural materials Nanostructuring is essential to promote rapid tritium release avoiding too high tritium inventories as well as tritium fuel deficit. Some techniques assure the required nanostructuring as e.g., synthesis via a cetyltrimethylammonium bromide (CTAB)-assisted hydrothermal method. The tritium breeding ratio (TBR) is enhanced by a neutron multiplier, by means of (n, 2n) reactions, due to its relatively large cross section, beryllium is an excellent neutron multiplier choice. In addition, it exhibits good thermal conductivity and mechanical stability further increased when mixed with Li2TiO3. In our simulations, we consider a breeding blanket based on Li2TiO3 and beryllium multiplier, with a reflector around the chamber to enhance the TBR. We have optimized parameters such as the reflector thickness or the overall concentration of beryllium (number of beryllium plates). We will show that for appropriate geometries lithium enrichment is not needed, which makes the design simpler and cheaper. Values of TBR as high as 1.37 were obtained with natural lithium with beryllium at 25 % (atomic fraction) in a breeder of 40 cm of thickness, constituting our best case.