TARGETS FOR Inertial fusion: PREPARATION OF GASEOUS FUEL MIXTURES WITH DIFFERENT AMOUNTs OF ADDITIVES FOR THE FORMATION OF ISOTROPIC CRYOGENIC LAYERS FROM HYDROGEN ISOTOPES

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Currently, in the inertial fusion energy (IFE) research, progress in plasma implosion up to intensive fusion reactions lies in formation of a given fuel structure that must be isotropic for reaching fusion conditions. Therefore, the modern requirements demand the development of structure-sensitive methods aimed at new layering techniques meeting the IFE target needs. To meet the demand for such IFE targets, the Lebedev Physical Institute (LPI) has made a significant progress in the technology development based on rapid fuel layering inside free-standing and line-moving targets, which refers to as FST layering method.

FST layering is a structure-sensitive method to form an isotropic ultrafine solid fuel (submicron crystalline or "fine-grained" crystalline and nano-crystalline) inside the polymer shells. High cooling rates combined with high-melting additives to fuel content results in creation of a stable ultimate-disordered structure with a high defect density or isotropic medium (ultrafine fuel layers), which supports the fuel layer survivability under target injection and transport through the reaction chamber. We underline that high-melting additives allows not only to obtain, but also to stabilize the ultrafine layer structure. Besides, the isotropic properties of such fuel structures allow for avoiding instabilities caused by grain-affected shock velocity variations.

In this report, we present the LPI studies aimed at determination of the preparation conditions of gaseous fuel mixtures for the subsequent filling of hollow polymer shells and layering of isotropic fuel structure. The following results have been obtained:

― Features of obtaining binary and triple mixtures of D2/H2 and D2/НD/Н2 with the content of additives to the main component in the mixture from 1 to 50% were studied.

― Effect of the appearance of small HD additives in the “Hydrogen + Platinum” system was experimentally observed. On the basis of this effect, an original method was developed for obtaining a binary H2/HD mixture with a HD content in the range of 0.03–0.56%.

― Experiments were carried out on freezing D2/Ne mixtures with different percentages of Ne (3 − 20%), which simulates tritium during FST layering. The goal is to show the promise of the FST method when working with D−T mixtures in a standard equimolar composition (25% of D2, 50% of DT molecules, and 25% of T2), as well as with a reduced T2 content because just T2 is considered as a high-melting additive with respect to D2 and DT.

Our findings (both theoretical and experimental) demonstrate that the conditions were determined, and installations for filling polymer shells with fuel gas with various amounts of stabilizing additives were created and tested. This allowed us to proceed to the stage of FST layering and to obtain ultrafine fuel layers which have a potential to advance materials for application to fusion targets fabrication in the form that meets the requirements of implosion physics.