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Synthesis of Li-Sn-Zn ternary alloy

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Abstract:

Fusion power plants based on the deuterium-tritium (DT) fuel cycle breeds the tritium fuel via neutron reactions with lithium. Hence, Lithium is incorporated in a breeding blanket that surrounds the fusion source. Because of the chemical reactivity of Li with water and air, an alternative alloy base on Li, Sn and Zn were investigated for this replacement. Recent work by LLNL proposed the used of liquid Li as the breeder in an inertial fusion energy (IFE) power plant [1]. Even though Li-Sn alloy may be used and does meet the TBR (tritium breeding ratio) and energy multiplication requirements, ternary alloy by the addition of Zn may improve the nuclear, thermal and chemical requirements.

Conventional melt mixing in tantalum crucible was carried out at temperature above 800°C in argon filled glove box. Typically, binary metals can be alloyed quite easily depending of heat of mixing. However, for ternary alloy, the result is not so clear because of the three competing kinetics as well as the tendency for phase separations. For example, melting $Li_{60}Sn_{20}Zn_{20}$ above 800°C and letting it cool, the resulting x-ray diffraction (XRD) spectra shows the present of Sn, Zn and LiOH and with Li may also be partially evaporated.

An alternative method of mechanical alloying to synthesize this ternary alloys was pursued. The method uses the SPEX 8000D mixer. The components of the sample were loaded into the machine steel vial in argon atmosphere. Stainless steel (316L) balls were used and the vials were also cooled using an in-house portable air-conditioner during milling. Samples of $Li_{60}Sn_{20}Zn_{20}$ and $Li_{70}Sn_{20}Zn_{10}$ were prepared. The powders were examined using XRD and differential scanning calorimetry (DSC) and the results clearly showed that the resulting powders are of a single cubic phase.

1- J.F. Latkowski et al., "Chamber Design for the Laser Inertial Fusion Energy (LIFE) Engine," *Fusion Science and Technology*, **60**, 54 (2011).

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