Volume and pressure of helium bubbles inside liquid Pb16Li. A molecular dynamics study

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Various concepts of breeding blankets are studied today, being the liquid Pb–Li eutectic alloy (Pb16Li) one of the most promising ones [1-3]. However, the behaviour of helium bubbles inside the liquid metal breeding blankets is not fully understood.

The physics of helium atoms inside metals has been well studied in the last 40 years, however, little attention has been devoted to helium inside liquid metals. Recently, we have investigated the nucleation and coalescence processes of helium atoms inside liquid eutectic Pb–Li alloys using atomistic simulations [4]. Several key findings regarding He bubbles inside liquid Pb16Li will be presented. The radius versus the number of atoms has been calculated in the temperature range 600–1000 K. The trend can be fitted and likely extrapolated to larger bubbles (micrometer size). The value of thermal expansion of He bubbles is given as well and compared to the thermal expansion of bulk He. The pressure inside He bubbles has been calculated as a function of bubble size. Finally, the importance of accurate interatomic potentials for the He–metal interaction will be discussed.

This work sets the basis for a multiscale modelling tool aiming to shed light on the complex phenomena of helium transport in liquid metals (i.e. Pb16Li, Li). Moreover, it can provide data about the behaviour of the Pb-Li eutectic in conditions where experimental results are not available [4, 5].

References:

[1] L Giancarli et al 2007 J. Nucl. Mater. 367–70 1271–80

[2] B Garcinuño et al 2018 Nucl. Fusion 58 095002

[3] Y Wu and the FDS Team 2007 Nucl. Fusion 47 1533–9

[4] A. Fraile. T. Polcar. 2020 Nucl. Fusion 60 046018

[5] A. Fraile A., S. Cuesta-López S., A. Caro A., D. Schwen and M Perlado J.M. 2014. J. Nucl. Mater. 448 103