Investigation of Deuterium Permeability of Sputtered Beryllium and Graded Copper Doped Beryllium Shells *

A. Nikroo, H.W. Xu, K.A. Moreno, K.P. Youngblood, and E.L. Alfonso
General Atomics, P.O. Box 85608, San Diego, CA 92186-5608

C.S. Alford, S.A. Letts, and R.C. Cook
Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550

Beryllium (Be) is the preferred ablator material for NIF ignition targets because of its low x-ray opacity and its high density, which lead to a more stable implosion. Graded copper doped Be shells have been fabricated by sputter coating on spherical mandrels. While such coatings have consistent microstructure and acceptable void content and size, we have found that they suffer from sufficient interconnected porosity leading to relatively rapid leakage of the fusion fuel, deuterium (D_2) in our examinations, out of the shells. In this paper, we present an extensive study of D_2 leakage out of Be shells made by sputter coating. Deuterium leakage out of shells has been measured by following the D_2 signal produced in a mass spectrometer from Be shells sealed with a glue plug after removing the mandrels through a laser drilled hole. The leakage appears to follow molecular flow dynamics as determined by examining the temperature dependence of the flow. It is also consistent with the relative leakage of heavier gases such as argon compared to D_2. Furthermore, the time dependence of the leakage suggests that the flow channels are ~ tens of nanometers in diameter propagating through the thickness of the coating, possibly brought about by residual stress in the coatings. We have investigated the D_2 time constant as a function of a large number of coating parameters, including the effect of introducing boron (B) doped layers. While addition of B doped layers, in general, has been most effective in producing shells with long time constants (> seven days to immeasurable), there is substantial scatter in the data even within a given coating batch, suggesting a possible stochastic cracking process driven by residual stress in the coating as the cause. The results of efforts to minimize such stress on the gas retention of shells will be presented.

*This work was performed under the auspices of the U.S. Department of Energy by General Atomics under Contract DE-AC03-01SF22260 and by the University of California Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.