BERYLLIUM CONTAINING PLASMA POLYMERS; THEIR PREPARATION AND CHARACTERIZATION

[1]N.C. Morosoff, [1]N.E. Barr, [2]W. J. James, and [3]R.B. Stephens

[1]Department of Chemical Engineering, University of Missouri-Rolla, Rolla, MO 65401
[2]Department of Chemistry, University of Missouri-Rolla, Rolla, MO 65401
[3]General Atomics, P.O. Box 85608, San Diego, CA 92186

INTRODUCTION

Beryllium rich coatings for potential use in inertial confinement fusion (ICF) experiments have been prepared. The coatings are to be used, typically in 100 micron thickness, on microballoons which will be subsequently filled with DT fuel and imploded with laser irradiation in the National Ignition Facility (NIF) to generate fusion energy.

The goal of the NIF project is to provide a facility that is capable of achieving fusion ignition. It will provide an experimental platform to study scale-up of the process to an ICF power plant, and to provide an above-ground capability for weapons-effect simulation.

The target is an approximately 2mm diameter spherical shell (microballoon) containing deuterium/tritium (DT) fuel and covered with a plasma deposited layer (ablator). The shell is inside a gold container (hohlraum). The laser pulse, focussed onto the inside of the hohlraum, produces a spatially uniform x-ray flux. This flux converts the ablator to a high pressure gas which compresses the fuel to a density and temperature such that a fusion burn occurs. The laser pulse and target structure are carefully tailored to, among other concerns, minimize mixing of ablator and fuel. That is caused by instability at the interface between the ablator and the fuel, and is a major concern; RMS surface roughness must be submicron for both inner and outer surfaces.

A beryllium (Be) ablator is being considered as an alternative (to a CH ablator) because it would have several important advantages. The higher initial density of the Be ablator reduces the time required for the first shock to cross the shell, thus shortening the initial part of the laser pulse. In addition, the resulting Be plasma is more transparent than the CH plasma. Both these changes would improve the deposition of energy onto the remaining ablator surface, and allow a larger margin of safety for ignition.

The requirement that DT fuel at high pressure permeate through the ablator, to fill the shell, precludes the use of pure Be and leads to the consideration of Be containing plasma polymers. Requirements for such coatings include beryllium content ranging from 50 to 100 atomic %, good permeability for hydrogen isotopes, and reasonable mechanical strength.

PLASMA DEPOSITION CONSIDERATIONS

In this study prototype beryllium rich coatings of uniform Be content have been prepared by two different methods of plasma deposition. The first (Method 1) involves thermal evaporation of Be and simultaneous codeposition of trans-2-butene plasma polymer (T2B-PP). The second (Method 2) involves plasma polymerization of diethylberyllium. Advantages of method 1 include independent control of the Be and T2B-PP deposition rates, relatively cheap reagents, and a plasma polymer whose preparation and properties are well understood. The important advantage of method 2 is reactor simplicity.

In contrast to most studies involving the production of metal loaded plasma polymers, the metal in this case (Be) is lighter than carbon. For method 1 this affects penetration of the metal beam into the plasma. For method 2 it affects the distribution of Be with respect to C along the length of the reactor. In both cases volatile Be containing compounds may be obtained in the byproduct gas to a greater extent than is observed for heavier metals.

Coatings made in this way are to be characterized as to hydrogen permeability, elemental composition, morphology, and nature of chemical bonding (infrared spectroscopy). Interim results of this study will be presented. We gratefully acknowledge support of this work by the Lawrence Livermore National Laboratory subcontract # B310613.