Fabrication of Overcoated Divinylbenzene (DVB) Shells

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The High Average Power Laser Program is a multi-lab effort to develop an Inertial Fusion Energy (IFE) reactor for electrical production. The driver would consist of modular Krypton Fluoride or Diode Pumped Solid State Lasers, direct drive targets, and dry wall chambers. Target models for this driver require a 4 mm diameter capsule with a core of deuterium tritium (DT) vapor and layer of DT ice, a layer of low density foam, filled with DT ice, a full density polymer overcoat, and a high-Z metallic overcoat. Requirements of the foam are a density from 30–140 mg/cm^3, cell size less than 5 microns, and possibly only containing carbon and hydrogen. Divinylbenzene was developed as a foam system to meet these requirements as the system can be produced within the density range of interest, has a cell size of 1-4 μm, and contains no oxygen. The ongoing development of DVB shells to meet the specifications of an IFE reactor is presented. The shells are formed using a water-oil-water emulsion microencapsulation technique and are agitated during thermal gelation to increase shell concentricity. An interfacial polycondensation technique using poly(vinyl phenol) reacted with an acid chloride was selected as a straightforward method to apply the full density overcoat. Research specification goals are as follows: 4 mm diameter, 300 micron foam wall thickness, 100 mg/cm^3 foam wall density, <1% wall nonconcentricity, 1-5 micron overcoat thickness, and overcoat surface roughness <20 nm RMS.   Diameter, wall thickness, density, and overcoat thickness requirements have been met. Two percent is the lowest nonconcentricity achieved for an individual shell; four percent is the lowest for a batch. 50 nm RMS surface roughness is the minimum that has been achieved. Formation, gelation, characterization, overcoating techniques, and methods to further reduce nonconcentricity and surface roughness are presented. Concepts to scale-up these processes are also presented as approximately 500,000 targets per day would be required by an operational IFE reactor.

Work performed under the auspices of the Naval Research Laboratory under contract **N00173-03-C-2023.**