

CHEMICAL VAPOR DEPOSITION OF POROUS SILICON CARBIDE ONTO
CERAMIC MICROSPHERES USING A FLUIDIZED BED REACTOR

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To Mom and Dad, who instilled in me the value of an education and have supported me through all of mine.

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ABSTRACT

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The Gas Fast Reactor (GFR) program in the United States requires novel nuclear fuel materials to achieve the fuel performance requirements for a fast neutron spectrum at high temperatures. Previous studies have shown that uranium carbide coated with a porous silicon carbide (SiC) layer and a dense SiC layer performs well in GFR conditions. A known process for coating the fuel is to suspend the microspheres in a fluidized bed (FB) reactor, flow a combination of gases over the particles to produce SiC on the surface of the particles through chemical vapor deposition (CVD). This thesis focuses on the use of methylsilane (CH_3SiH_3) as a SiC precursor, the experiment built at Purdue University's Fuel Cycle and Materials Laboratory (FCML) to test it, and the results of that experiment.

The experiment utilized two designs for a fluidized bed that resulted in eleven coating runs. Of these coating runs, the last three demonstrated that a porous and a denser layer of SiC deposited on ceramic microspheres may be produced from a fluidized bed reactor using methylsilane gas. These experiments were conducted at 1200°C and 900°C , where the porous layer is deposited at 1200°C and the denser layer is deposited at 900°C . The last three coating runs used a total deposition time of one hour, three hours, and five hours and resulted in coating thicknesses of $3.58 \pm 0.32\mu\text{m}$, $10.18 \pm 1.68\mu\text{m}$, and 95.32

$\pm 1.03\mu\text{m}$ respectively. The deposition rate for this system is approximately $0.05\mu/\text{min}$ for 900°C and $0.06\mu/\text{min}$ for 1200°C .