Formation of Molybdenum Borides and Their Composites by Combustion Synthesis with Solid-phase Displacement Reactions

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ABSTRACT

An experimental study on formation of molybdenum boride (MoB) was conducted by self-propagating high- temperature synthesis (SHS) using compacted samples from elemental powder mixtures. Upon ignition, the reaction was characterized by a planar combustion front propagating along the sample in a self-sustaining manner. In the synthesis of monolithic MoB, effects of the initial sample density and preheating temperature on combustion characteristics and the composition of final products were studied. Flame-front propagation velocity and combustion temperature were found to increase with initial sample temperature and density. Based upon the measured data, the activation energy of combustion synthesis of MoB was determined as 80.44 kJ/mol. For the reactant compacts with Mo:B = 1:1, the XR D analysis identified formation of α-MoB as the dominant phase and Mo2B as the intermediate phase. Formation of molybdenum borides of four different phases, including Mo2B, MoB2, Mo2B5, and MoB4, was performed by self-propagating high-temperature synthesis (SHS) from the reactant compacts composed of MoO3, Mo, and B powders. The solid-phase displacement reaction of MoO3 with boron was involved in the SHS process. The effect of starting stoichiometry on flame-front propagation velocity, combustion temperature, and product composition was studied. In all cases, experimental observations show a planar reaction front propagating in a stable and self-sustaining manner. During the reaction, misty boron oxide in the form of small liquid droplets was produced in the displacement reaction and ejected from the sample. Thus, the end product was significantly expanded. A decrease in the displacement reaction taking place during viithe SHS process reduces the heat flux to the synthesis reaction,thus resulting in lower combustion temperatures and reaction front velocities. The hihest combustion temperature was observed in the synthesis of MoB2, followed by Mo2B. The reaction temperature of Mo2B5 is comparable to that of MoB4. Based upon the XRD analysis, formation of MoB2 and Mo2B5 as the dominant boride phases in the end products was successful. It was found a large amount of Mo left in the synthesis of Mo2B. However, the powder compact prepared for the production of MoB4 yielded mostly Mo2B5.

Keywords : Molybdenum borides, SHS, Displacement reaction, Flame-front velocity, Combustion temperature.

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