Preparation of CoAl、CoTi and Ti-Si Intermetallic Compounds by Combustion Synthesis in Self-propagating Mode

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ABSTRACT

The self-propagating high-temperature synthesis (SHS) of CoAl, CoTi and Ti-Si intermetallic compounds was investigated. This study was divided into two parts. In the first part, the formation of CoAl and CoTi intermetallics was examined. Effects of the initial sample density, particle size of the reactants, and initial sample temperature on the combustion characteristics, as well as on the composition of final products were studied. In the second part, Ti-Si intermetallics with different stoichiometric ratios were produced. Effect of the initial stoichiometry on the combustion temperature and the flame-front velocity, as well as on the final composition of burned products was studied. In the first part, the steady propagation of the self-sustained flame front was observed on both types of samples, and afterburning reaction was found in the synthesis of CoTi compounds. The flame-front propagation velocity and combustion temperature were found to increase with increasing sample green density and initial sample temperature in CoAl and CoTi systems. In the formation of CoAl, the initial sample temperature and particle size of reactants significantly affected the flame-front propagation velocity when the samples with a low initial density were used. XRD analysis indicated that complete conversion was achieved in the synthesis of CoAl and CoTi compounds. Based upon the dependence of flame-front velocity on combustion temperature, the activation energies associated with the formation of CoAl and CoTi by SHS were deduced to be 121.69 and 67.95 kJ/mole. In the second part of study, it was found that all kinds of SHS processes were characterized by the steady propagation of the flame front.Experimental results showed that combustion temperatures of samples with all stoichiometric ratios were higher than the Ti-Si eutectic temperature 1330 oC, except for the sample with a composition of Ti:Si = 1:2. The flame-front propagation velocity of sample of Ti:Si = 1:2 was between 3 and 5.3 mm/s, which was much lower than those (between 20 and 60 mm/s) of samples with other compositions (Ti:Si = 5:3, 3:2, and 5:4). XRD spectra showed that the samples of Ti:Si = 5:3 and 3:2 produced the fully-reacted compound Ti5Si3. The compact with Ti:Si = 1:2 yielded dominantly the TiSi2 phase. However, the samples with Ti:Si = 5:4 and 1:1 yielded multiphase products consisting of TiSi, Ti5Si4, and Ti5Si3. Activation energy with the value of 201.21 kJ/mole was determined for the formation of Ti5Si3 by SHS.

Keywords : Self-propagating High-temperature Synthesis ; CoAl Intermetallics ; Ti-Si Intermetallics

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