Combustion synthesis of Ti_3SiC_2 skeleton with infiltration by tin melt

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In this paper, the possibility of using combustion for simultaneous synthesis of ceramic compound of MAX-phase Ti_3SiC_2 in the form of a porous skeleton and spontaneous infiltration of its pore body with liquid tin to obtain the Ti_3SiC_2-Sn cermet according to the author's method [1, 2]. The synthesis of the Ti_3SiC_2 skeleton by combustion was carried out from a mixture of titanium (~300 μm), silicon (~5 μm) and graphite (~15 μm) powders taken in the ratio 3Ti+1Si+2C. The combustion process was characterized by a temperature of over 2000 °C, the velocity of the combustion wave ~ 6 mm / s, and the structure formation of the target compound Ti_3SiC_2 after the passage of the combustion wave could take up to 6-8 seconds. Taking into account the fact that the process of secondary structure formation continues in an already burnt and rapidly cooling SHS skeleton, which is able to spontaneously absorb the metal melt due to the action of capillary wetting forces immediately after combustion, it was necessary to study the effect of the presence of tin melt in the pores of the hot skeleton on the ongoing process of secondary structure formation of Ti_3SiC_2.

Within the framework of this work, a technique for producing Ti_3SiC_2-Sn cermet was developed, which ensures the combination of the combustion process and the completion of the formation of the Ti_3SiC_2 skeleton together with high-temperature infiltration by tin melt. Melts of pure tin and Sn-10%Pb alloy were not infiltrated into the Ti_3SiC_2 skeleton at a melt temperature of 400 °C. However, the tin melt is spontaneously impregnated by ~120 mm if the melt temperature is increased to 800 °C. It was found that, firstly, the tin melt does not destroy the MAX phase of Ti_3SiC_2, and secondly, the premature ingress of tin melt into the SHS skeleton practically does not interfere with the process of Ti_3SiC_2 structure formation.

A study of the density distribution of the obtained cermet along the length showed a stable decrease in density from the beginning of the sample in contact with the tin melt to the end from 6.02 g/cm^3 to 4.49 g/cm^3, which indicates a corresponding increase in residual porosity from ~ 0% to ~ 25.1%. The study of the microstructure showed the presence of a significant number of Ti_3SiC_2 plates along the entire length of the cermet. According to the XRD analysis data, the phase composition is Sn, Ti_3SiC_2 and TiC.

Thus, it was found that the temperature of the tin melt significantly affects the possibility of infiltration into the hot porous skeleton of the MAX phase Ti_3SiC_2. It was also found that the tin melt does not exhibit destructive chemical activity in relation to the 3Ti-Si-2C powder system, that is, it does not prevent the formation of Ti_3SiC_2 and does not destroy it.

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References

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