SYNTHESIS OF MIL COMPOSITES BY VARIOUS METHODS[1]

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Progress in the creation of new technological innovations mainly depends on the development and improvement of technologies for obtaining materials with required properties, so the creation of materials with desired structural and functional properties is currently an area of increased attention in materials science and technology. The new promising class of structural materials includes metal-intermetallic laminate composite materials (MILCM) which are represented by a multilayer composition with alternating metal and intermetallic layers [1, 2]. These composite materials are attractive for use in aerospace engineering and many other areas, and methods for obtaining of MILCM allow us to use new technologies expanding the functionality of laminate composites and the area of application.

This work considers four methods such as thermal explosion, reaction sintering, reaction compression, and explosive welding + sintering for the obtaining of Ti-$TiAl_3$ metal-intermetallic laminate composite materials.

A powder mixture of titanium and aluminum with a stoichiometric composition (37.2 wt% Ti + 62.8 wt% Al) was used to synthesize titanium tri-aluminide ($TiAl_3$). To conduct the synthesis, a setup was specially designed. A tungsten-rhenium 200 micron thermocouple placed in the powder layer of the sample was applied to determine temperature. Ti and Al plates and a PM-12M muffle furnace were used for reaction sintering. The reaction compression (reaction sintering together with constant pressure) was conducted using a special setup at Institute of Metal Physics UB RAS (Yekaterinburg).

In the work the Ti and Al plates were used, and temperature, pressure, and the process time were varied. Explosive welding was conducted in an explosive chamber (Lavrentyev Institute of Hydrodynamics SB RAS, Novosibirsk). The samples obtained by explosive welding were subjected to a reaction sintering in a muffle furnace at the temperatures of 700 and 900°C for 2, 4, 6 and 8 hours. The microstructure and phase composition of the samples were studied by the X-ray diffraction, local X-ray spectrum and optical microscopy methods.

The study showed that the multilayered composite could be obtained by all four methods. However it should be noted that there are disadvantages in each of these methods. After synthesis in the thermal explosion mode, high porosity and low strength are observed in the intermetallic layers of the samples. There are also problems concerning mechanical and physico-chemical compatibility of different materials at the boundary between layers, which leads to the absence of a strong bond between the titanium foil and synthesized intermetallide. High porosity and low strength were observed in the intermetallic layer after reaction sintering, and increased porosity was formed in the middle of the intermetallic layer. A central layer of increased porosity was also formed after explosive welding and sintering, which reduces strength characteristics of the composite. The method of reaction compression partially solves the problem of high porosity in the intermetallic layer, but nevertheless, there are pores nonuniformly located in the layer, which requires an additional improvement of modes for the synthesis of metal-intermetallic laminate composite materials.

REFERENCES

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