Structure features of the composite material Inconel 625/TIC, produced by LMD method

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At the present time usage of composite materials, which contains ductile metal matrix reinforced with hardening particles, are increasing. One of the perspective ways to manufacture these objects is laser metal deposition (LMD).

In this paper, the metal composite Inconel 625/TiC produced by LMD method was investigated. The samples were prepared at the follow parameters of the process: the scan speed was 500 mm/min; the laser spot diameter was focused at 1 mm; the laser power were varied at 400, 600, 800 and 1000 W; parallel melting strategic was used. The Inconel 625 powder with the particle size 50-140 μm was synthesized by gas atomization method and the TiC powder with particle size 20-50 μm was produced by method of self-spreading high-temperature synthesis. During LMD process, powder was carried by argon, powder feeding rate was 3 g/min, C20 carbon steel was a substrate. The composite Inconel 625/TiC contained 20 % carbide TiC.

The powders in the three different states were used for melting samples:

1) the initial powders Inconel 625 and TiC were fed from single flasks;
2) the initial powders Inconel 625 and TiC were previously mixed in a gravitational mixer with a rotation speed of 60 rpm;
3) the powders were mixed in a planetary ball mill with a rotation speed of 200 rpm using balls from the steel Fe-1%Cr-1%C; a milling time was 8 h.

The structure of both the powders in the different states and the recrystallized composites were studied by methods of metallographic and X-ray analysis, scanning and transmission electron microscopy. Microhardness of the composite materials was determined yet.

It was established that the initial powder state influences on the macro- and microstructure of the melting objects. Only composites obtained from the powders previously mixed in a planetary ball mill had no cracks. At usage the powder in another states, grown composites had backbone cracks. When cracks did not arise in the composite materials, the carbide particles TiC had initial spherical shape and initial composition. In those cases when cracks appeared, the carbides have dendritic shape, and their composition are changed: Mo from the matrix dissolves in the carbide phase.

Investigation of the powder materials obtained by different methods is showed that during mixing the individual particles of the Inconel powder are covered with layer of titanium carbide. This effect is larger at mixing in a planetary ball mill. As a result, the thermophysical properties of Inconel powder are changed, and an energy required for recrystallization of the Inconel powder is increased.