PRODUCTION OF MATERIALS WITH ULTRAFINE STRUCTURE OF ALUMINUM ALLOY BY FRICTION STIR PROCESSING

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Friction stir processing is a promising and popular method for the formation of an ultrafine-grained structure on the surface of materials based on plastic deformation during frictional contact [1-9]. The processing takes place by inserting a rotating pin into the material by heating the metal in the contact area and moving the tool along the specimen. As a result, material is mixed in the zone determined by the size of the pin and the arms of the tool, which leads to grain refinement and a change in the structural-phase state. This method can produce materials with an average grain size of less than 1 μm, without affecting the internal volumes of the material. Also by this method it is possible to form volumetric ultrafine-dispersed materials. Despite the large amount of recent work on this subject, up to the present time there is little data on the formation of a material with a large machined surface area in several passes by a tool. In the present work, a study was made of the material obtained on the surface of samples of alloy D16 in steps 1, 2 and 3 of the passes with different types of instruments along the sample line.

The processing of sheet rolled products of alloy D16 was carried out on a laboratory installation for friction stir welding with ISPMS SB RAS. Investigation of the distribution of secondary-phase particles was performed with a scanning electron microscope NIKKISO SM3000. The investigation of the grain structure was carried out on an optical microscope Altami MET-1C. The structural-phase state studies were carried out using a JEOL JEM-2100 transmission microscope.

The carried out researches show that in carrying out multiple passes in the zone of intersection of mixing zones of the sheet metal material, a slight increase in the average size and volume fraction of the particles of stable secondary phases is observed in a number of cases. The grain size of the mixing zone also remains at 1 μm and does not undergo significant changes. On the boundaries, in triple junctions and in the bodies of grains of the α-Al solid solution, secondary phase precipitates of various dispersity and shape are deposited.

The results of identification of typical microdiffraction patterns obtained during TEM studies showed that the grains of the α-Al solid solution have zone axes of the type <110> (predominantly), as well as <113> and <134>. That is, the crystallographic axes of the type [110], [113] and [134] are parallel to the processing axis. This phenomenon is also observed by the authors of other works in the field of friction, friction with mixing and rolling.

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