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STRUCTURE FORMATION DURING ADHESIVE INTERACTION UNDER FRICTION STIR WELDING CONDITIONS

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At the present time, thermally wrought Al-Mg alloys with high strength characteristics are used to create the parts for space applications. The Al-Mg-Sc-Zr alloy is the most advanced representative of this family of materials. The yield strength of Al-Mg-Sc-Zr alloy is 1.5 times higher than its analogues. As a result, the wall thickness, and the weight of the structure can be reduced by 20 %, as all aircraft structures operate in the field of elastic deformation. However, this alloy does not weld by traditional welding methods. In this paper, the friction stir welding (FSW) method was studied, which involves the one pass joint of large thicknesses plates. To create a quality weld, it is necessary to reveal the regularities of structure formation at the FSW of large thicknesses plates, which will help technologists in the selection of modes.

In this work, the structure formed in the FSW process was studied on bimetallic joints and Al-Mg-Sc-Zr alloy joints with a thickness of 30 mm and 35 mm.

In the model experiment, showing the formation of a layered structure during FSW, the Al-Mg alloy and copper were used. Fulfill a function of the marker, copper was distributed over the stir zone in the form of a layered structure known as "onion rings". This structure shows that friction stir welding is conducted by the layers formation and material transfer.

In the study of the plastic flow of the material in the area from the tool outlet, it was found that the microstructure at different levels of the horizontal sections of the Al-Mg-Sc-Zr alloy sample thickness is the same. This indicates that the layer-by-layer transfer mechanism is macroscopic. As a result of the conducted research of FSW joints of Al-Mg-Sc-Zr alloy of large thicknesses it was revealed that the structure of the stir zone is a dynamically and initially recrystallized area. A similar structure is observed in sliding friction, and the area, where the material experiences less deformation and lower temperature, is similar to thermomechanical affected zone in friction stir welding. The similarity of the structure testifies to the similarity of the mechanisms occurring in these processes. In the previous studies on the regularities of the transfer layers formation as a result of the adhesion contact of the pair "aluminum alloy - steel" in the sliding friction, it was found that between the aluminum alloy and the steel ball there is a direct and reverse metal transfer [1, 2]. A similar mechanism of material transfer occurs in friction stir welding as well. It is assumed that the aluminum alloy, strongly deformed due to the conditions of comprehensive compression, normal and tangential loading, begins to form adhesive bonds with a steel tool. Due to this interaction, the welding tool grips a layer of a certain thickness and moves it convectively to the area behind the tool. This process of transfer is repeated layer-by-layer with the successive periodic transfer of material by means of adhesive interaction. Thus, a pronounced layered (onion) structure is formed in the stir zone of the welded joint.

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