Modeling of the plastic deformation of metal-intermetallic layered composites

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Layered metal-intermetallic composite materials constitute a large class of practically in demand materials. High strength of such composite is achieved by intermetallic layer, plasticity - due to the metallic layer. To create composite materials with good strength properties and capable of operating under different operating conditions theoretical investigations are needed. In this work, deformation of layered composite materials subjected to single-axis high-speed compression and tension by theoretical methods was studied. The investigation of deformation and fracture of layered composite materials of the metal-intermetallic type was carried out by the theoretical method in the framework of the approach combining the models of dislocation kinetics of alloys with the $L1_2$ structure and pure metals and the model of continuum mechanics. The inclusion of the model of dislocation kinetics in the model of continuum mechanics is due to the need to specify the plastic behavior of the materials composing the layered composite.

Numerical implementation of this method modeling was carried out by the finite element method in the RANET-3 software complex. This synthetic model allowed us to describe the process of formation and development of macroscopic shear bands under uniaxial high-temperature deformation of single crystals of the alloy with the $L1_2$ structure. However in comparison with the single phase materials, heterophase (composite) materials are widely used in practice for the production of turbine and nozzle blades of gas turbine engines for aviation and power engineering. In this regard it was important so much to study the plasticity and loss of high-strength properties of composites based on high-temperature alloys with the $L1_2$ structure.

The products made of composite materials, which are based on heat resistant alloys with $L1_2$ structure, are used under different temperature conditions. It was necessary to study the deformation behavior of the laminates under different temperature and loading conditions. Therefore the influence of the location, width and volume fraction of pure metal layers on the plastic properties of the composite under dynamic tension and compression for deformation temperatures in the range from 4.2 K to 873 K was analyzed. It was shown that the introduction of the vertical pure metal layers into the intermetallic sample gives a greater increase in the strength properties of the deformed sample in comparison with horizontally arranged layers. For low temperatures (4.2 K and 77 K) the presence of pure metal layers did not have a significant effect on the degree of strain before fracture. Increasing the temperature up to 423 K, 523 K, and 623 K leads to a significant increase in the degree of strain before fracture for both horizontal and vertical arrangement of the layers of the laminate in the some geometrical conditions of the laminate. The inclusion of vertical metal layers in the intermetallic sample suppresses the formation of the macroscopic shear bands at a temperature of 873 K, which were observed in single-phase intermetallic sample under high-temperature compression.

Keywords: **Intermetallics, tension, compression, laminates, modelling, FEM**

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