Structure modification of Cu-Al system polymetallic materials obtained by electron-beam additive technology

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At present, additive manufacturing technologies are intensively developed, improved and modified, as evidenced by a large number of reviews and experimental works in scientific literature [1-5]. The technologies based on melting and sintering of powder materials by means of laser beam (SLS, SLM technologies) or electron beam (EBM technology) have received the greatest development in the modern literature. Last years the technologies based on direct material deposition in a printing zone are gaining topicality, the most implementable of which in industrial sphere are technologies of wire-arc 3D-printing (WAAM technologies) and wire-feed electron-beam additive manufacturing (EBAM technologies). One of the advantages of the wire-feed electron-beam additive technology is to obtain large-sized components from different materials, as well as polymetallic ones with a gradient transition zone between materials [6-8]. However, in the process of polymetallic components manufacturing by additive electron-beam technology, in addition to the large-crystalline structure with poor strength there is the formation of building defects as intermetallic interlayers and delaminations along their boundary. Refinement of structural elements and reduction of its distribution heterogeneity can be achieved using friction stir technology [9]. The purpose of this work is to study structural and phase changes in the polymetallic material of Cu-Al system after friction stir processing. Aluminum alloy 5356 and copper C11000 as wire filaments with diameters of 1.2 and 1.0 mm respectively were used as feedstock for additive manufacturing and further processing. Printing was performed in the sequence "copper-aluminum alloy". The obtained structure after electron-beam additive 3D-printing is represented by initial alloy materials with presence of solid solutions and intermetallic phases based on copper and aluminum in the structural gradient zone. There are also a large number of defects such as pores and cracks. After friction stir processing, the originally coarse-crystalline material structure was modified with the formation of fine-grained structure of the stir zone. In addition to reducing structural heterogeneity after processing, no pores or delaminations are detected in the stir zone material, which results in increased mechanical properties in tensile tests.

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