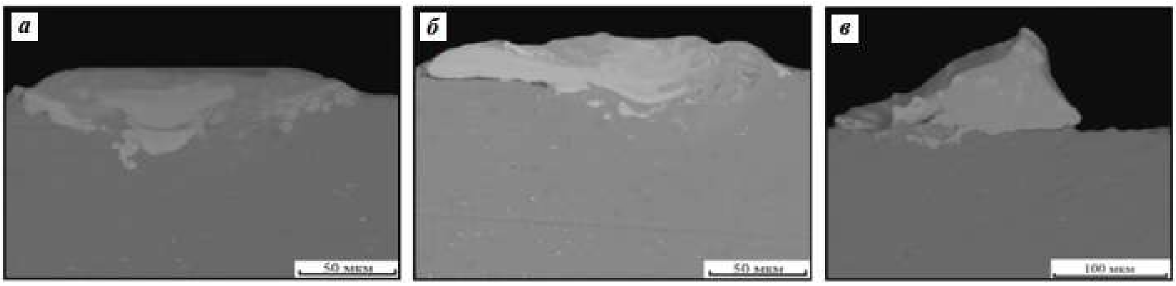

Fig. 2. Structure of single tracks in cross section at different laser scanning speeds, mm/s: 300 (а), 600 (б) and 900 (в) (SEM)

The uniformity of distribution of Ti and Al in the cross section of single tracks was assessed using maps of the distribution of elements. Structural components were determined with using X-ray microanalysis.

Sintering modes determine the morphology of single tracks obtained from a mixture of titanium and aluminum powders, as a result of which their correct selection is necessary to obtain stable tracks.

INFLUENCE OF TEMPFORMING TEMPERATURE ON THE MECHANICAL PROPERTIES OF A LOW-ALLOY CHROMIUM-MOLYBDENUM STEEL

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Carbon and low-alloy steels are widely used as structural materials in construction and mechanical engineering. The widespread introduction into industrial production of thermomechanical treatment with controlled cooling has significantly reduced the cost of these steels, which has made it possible to significantly expand the scope of their application. One of the disadvantages of such steels is their relatively high brittle-ductile transition temperature after improvement, which makes these steels brittle and limits their use at low temperatures.

Traditional approach to suppress brittle intercrystalline fracture includes grain refinement and precipitation of dispersed particles along grain boundaries, inhibiting the propagation of an intercrystalline crack. On the other hand, delamination of the material crosswise the direction of crack propagation dulls the crack tip and thus increases the fracture toughness. In this regard, methods for improving the mechanical properties, primarily the impact toughness at low temperatures, of carbon and low-alloy steels are of particular interest.

A low-alloy chromium-molybdenum steel with a chemical composition of Fe - 0.36C - 0.56Cr - 0.57Mn - 0.54Mo - 0.4Si (all in mass%), was subjected to tempforming at 823, 873 and 923 K to a total strain of 1.4. Tensile tests were carried out using an Instron 5882 testing machine at room temperature on flat specimens with a gauge length of 12 mm and a cross section of 3×1.5 mm^2 cut along the rolling direction. Impact tests were carried out on standard specimens with a square cross section of 10×10 mm^2 and a length of 55 mm with a V-notch stress concentrator using an Instron 450 J impact machine with an Instron Dynatup Impulse data acquisition system in the temperature range from 183 to 293 K. Impact test specimens were cut so that the direction of impact was parallel to the normal rolling direction.

Both the yield strength and the ultimate tensile strength decreases while elongation increases with an increase in temperature of tempforming. At tempforming temperature of 823 K, the yield strength is 1540 MPa, and total elongation is 5.3%. With an increase in tempforming temperature to 873 K, the yield strength decreases to 1350 MPa, and total elongation increases to

8.1%. Further increase in tempforming temperature to 923 K results in the yield strength of 1180 MPa and total elongation of 12.1%. The steel samples subjected to tempforming at 823 K exhibit impact toughness of KCV = 265 J/cm^2 at room temperature. A decrease in the test temperature to 233 K leads to a slight decrease in the KCV value to 200 J/cm^2. At a test temperature of 183 K, an increase in the KCV to 276 J/cm^2 is observed. The steel samples subjected to tempforming at 873 K exhibit impact toughness of KCV = 157 J/cm^2 at room temperature. A decrease in the test temperature to 183 K leads to a increase in the KCV value to 400 J/cm^2. The steel samples subjected to tempforming at 923 K exhibit impact toughness of KCV = 190 J/cm^2 at room temperature. A decrease in the test temperature to 273 K leads to a increase in the KCV value to 330 J/cm^2, which practically does not change to a test temperature of 183 K. It should be noted that the impact specimens do not completely destroyed (except for the sample subjected to tempforming at 873 K and tested at room temperature), suggesting underestimation of the impact toughness. The high fracture toughness is attributed to delamination, when the fracture is accompanied by splitting along the rolling plane with high energy absorption.

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A POSSIBILITY OF OBTAINING CORROSION-RESISTANT DEFORMED SEMIFINISHED PRODUCTS FROM AN ALLOY BASED ON THE AL-CA-MG SYSTEM

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The aim of research in this work is to substantiate the possibility of obtaining a corrosion-resistant alloy doped with calcium and magnesium, which has high mechanical properties in comparison with wrought commercial alloys of 5xxx series, such as AMg2 (AA5251). The alloy is additionally alloyed with manganese as one of the strengthening elements of the aluminum matrix, as well as with small additions of zirconium and scandium, which have found wide application in magnals [1]. The final composition is as follows: Al – 2.5Ca – 2.5% Mg – 1% Mn – 0.4% Fe – 0.1% Sc – 0.2% Zr. The presence of iron is due to the ability of calcium to bind it into the ternary compound $Al_{10}CaFe_2$ [2], which is part of the multiphase eutectic.

The structure of the alloy is characterized by the presence of eutectic veins located along the boundaries of dendritic cells (Al). The MPCA data show that the eutectic constituents include 3 phases: (Al), Al_4Ca and $Al_{10}CaFe_2$. At the same time, manganese and magnesium, as well as zirconium and scandium are included in the Al matrix. These data are in good agreement with the calculated data obtained in Thermo-Calc.

In the process of hot rolling (at 400 °C) from an ingot with a thickness of 15 mm, the alloy showed high manufacturability, as evidenced by the absence of transverse cracks and defects on the surface of the hot-rolled semi-finished product (thickness 2 mm, total reduction 87%). In the course of thermal deformation processing, it is possible to change the shape of the structure. Eutectic secretions of compounds with calcium and iron acquired a compact, rounded shape. Also nanoscale precipitates of $Al_3(Zr,Sc)$ and Al_6Mn phases with sizes of 5-10 and 200-300 nm, respectively, are observed in the structure.

The study of mechanical properties showed an increase in hardness by 35% (from 88 to 120 HV). This indicates a high level of strength, which was confirmed. Thus, in the hot-rolled state, the alloy has $\sigma w = 391 \pm 3$ MPa, $\sigma 0.2 = 356 \pm 3$ MPa, $\delta = 2.6 \pm 0.4\%$. These indicators exceed the values of similar properties of the AMg6 alloy ($\sigma_w = 375$ MPa, $\sigma_{0.2} = 275$ MPa, $\delta =$