The Effect of Intense Plastic Deformation on Phase Composition and Structure of Pearlite in Boron-Bearing Alloys

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It is known, that intense plastic deformation of iron-based carbon-bearing alloys causes fragmentation of cementite plates. But processes of plastic deformation effect on pearlite morphology for iron-based boron and carbon-doped alloys are not sufficiently studied.

The study was performed for specimens of the size of 30x30 mm with carbon content of 0,25 % (w.) and for alloys with carbon content of 0,25 % (w.) and boron content of 0,005 % (w.). Specimens were preannealed at the temperature of 1123 K for 5 hours and then were deformed to values of relative deformation of 10-40 % or were subjected to high-speed deformation. The microstructure of pearlite of alloys was determined by means of JSM-6490 microscope, optical microscope "Neophot-21" and electron microscope. The X-ray structural analysis was performed by means of diffractometer DRON-3 in monochromated Fe-K_α radiation.

When degree of plastic deformation is 10 %, there are no changes in microstructure of pearlite of iron-based alloy with carbon content of 0,25 % (w.). When deformation degree increases to 25 %, in pearlite grain of alloy partial shattering of cementite plates takes place. Partially in a volume of ferrite grains the formation of cementite inclusions of the size of 1,5-2,5 μm is observed. Under prior plastic deformation with degree of 40 % along with formation of light-side cementite plates there heavy side plates are formed, and occasionally the grained pearlite regions of the size of 2 μm are observed. Besides, volume ratio of pearlite decreases and comes out to 25 %. On the grain boundaries and sometimes inside the ferrite grains the formation of cementite inclusions of the size of 2,0-3,5 μm is observed. In microstructure of steel during high-speed deformation not only pearlite plates, but also ferrite grains are shattering.

Boron doping of iron-based alloy is attended with formation of more finely divided pearlite. When degree of alloy deformation is 20 % the formation of areas of finely divided grained pearlite with volume ratio of 20 % takes place. The enhancement of deformation degree leads to increase of volume ratio for the grained pearlite. Moreover, the formation of single particles of boron cementite $Fe_3(CB)$ inside the ferrite grains is observed in microstructure. It should be noted that phase composition of pearlite consists of ferrite and boron cementite. The high-speed deformation of alloy is characterized by more consertal structure of ferrite, than for carbon alloy. Almost all the pearlite is of grainy morphology. Inside the ferrite grains the finely divided inclusions of $Fe_3(CB)$ phase are observed. The presence of $Fe_{23}(CB)_6$ phase inclusions of the size of 0,05-0,07 μm inside the ferrite grains is revealed by means of electron microscope.