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INCREASE FORGED STEELS ENDURANCE

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Summary: are results of non-metallic inclusions form influence research on low-cycle endurance forged manganese steels are presented.

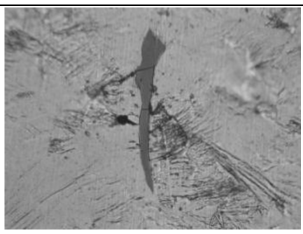
Key words: forged steels, low-cycle endurance, deoxidation, non-metallic inclusions, manganese steels, longitudinal sample, cross-sectional sample.

The organization of problem. Resistance of forged steels to fracture under cyclic loads is one of the factors determining the durability of the products made from them. The morphology influence of the non-metallic inclusions and structure of the metal basis for the process of the wrought steel fracture has not been studied details. In connection with the fact that the final deoxidation (modification) is the most technological and economic method for control the structure formation processes began to study of the effect of ferrocerium modification on one of the indicators of the structural strength of steel – the low-cycle endurance has been studied. According to numerous published sources, the form of non-metallic inclusions plays a prominent role in the processes of fatigue cracks generation and alloys destruction under cyclic loading. However, these investigations do not fully explore the process of wrought steel destruction.

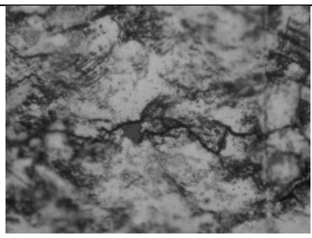
The fundamental materials of investigations. The purpose of this paper work was to investigate the effect of the ferrocerium modification compared to deoxidation aluminum of steels with low (0, 09%) and medium (0, 40%) carbon content on low-cycle endurance considering influence of technological texture.

The materials resistance fracture under low-cycle fatigue is called low-cycle endurance. It criterion is a cyclic durability N - the number of cycles of stress or strain, with standing the sample before the formation of macro-cracking or breaking. In practice, there is a nominal limit of 50000 cycles, which separates the low-cycle fatigue from high-cycle fatigue. The other peculiarity of the research on low-cycle endurance is elastic-plastic deformation unlike elastic deformation at high-cycle endurance [1]. Were confirmed by the data the form of non-metallic inclusions influence on the intensity of crack formation [2, 3]: in particular, globular inclusions caused the formation of small cavities, the elongated inclusion of the second type has caused cracks of considerable length.

The role of non-metallic inclusions in the processes of destruction of manganese steels with iron-manganese sulphides and globular cerium inclusions of the cyclic alternating loads on longitudinal and cross-section at samples has been evaluated. The researching of the fatigue fracture mechanism has been conducted under deformation of 0, 35%, with, on the one hand, polished surface, being photographed after various number of cycles. The analysis of fracture micromechanism when studied low-cycle endurance showed that the largest extent the processes of cracking facilitated to the inclusion of iron-manganese sulphides. Such inclusions were the emergence of microcracks, some of which resulted in the formation of major crack and further increase in the number of loads. In that case, when the line of action of tensile loads coincided with the direction of metal flow and inclusions under plastic deformation, the role of the inclusions in the process of nucleation and spreading of cracks sharply decreased, the microcracks appeared more often in inclusion (fig. 1, a). The most dangerous inclusions, which contributed to the accelerated fracture of steel, being found themselves as stretched nonmetallic inclusions in case when breaking load was normal to the direction of plastic deformation (fig. 1, b). In the field of globular forms inclusions the cracks were also formed, but their velocity of nucleation and growth lagged significantly behind the rate of nucleation and growth of cracks in the field of stretched inclusions (fig. 1, c, d).



a



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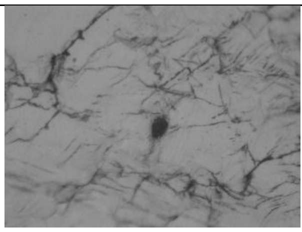

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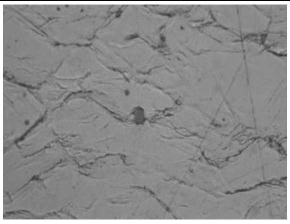

d

Fig. 1. The non-metallic inclusions content presence in the fracture of samples: 09Г deoxidation Al, longitudinal sample (a); 09Г deoxidation Al, cross-sectional sample (b); 09Г deoxidation Al+Ce, longitudinal sample (c); 09Г deoxidation Al+Ce, cross-sectional sample (d).

The influence of different types of non-metallic inclusions on low-cycle endurance has been studied at the wrought manganese steels 09Г and 40Г using two ways of deoxidation: aluminium; aluminium and ferrocerium. The samples were cut in the longitudinal and transverse directions of forged and polished the surface from one side. The influence of the final modification to the decrease of anisotropy endurance metal has been studied. Nonmetallic inclusions, which belonged to the inclusions of the second type in the case of external loads action across the direction of orientation inclusions, caused destruction of metal at much lower cycle variable loads than if the load were directed along the direction of inclusions. In that case, when steel was studied after deoxidation ferrocerium and aluminium with globular inclusions of the first type, the anisotropy of the properties decreased sharply (table 1).

Table 1

The stress intensity factors for kinetic diagrams fatigue, low-cycle endurance and K_{1C} of steels 09Г, 40Г and 50Г

Steel grade	Type of sample	ΔK_{th}	ΔK^{*}	ΔK_{fc}	Low-cycle endurance	K_{1C}
		MPa·m$^{1/2}$			N, thousand cycle	MPa·m$^{1/2}$
09Г	11 longitudinal	13	21	70	10,6	45,05
	11 cross-section	13	20	60	6	39,02
	12 longitudinal	14	22	80	10,9	66,5
	12 cross-section	14	22	80	8,6	60,1
50Г	41 longitudinal	12	23	89	8,8*	65,05
	41 cross-section	12	22	70	5,8*	54,82
	42 longitudinal	8,3	20	91	9,0*	86,6
	42 cross-section	8,3	20	91	8,2*	76,8

* Research has been conducted on steel 40Г

Conclusions. On the basis of the research having been conducted the conclusions showed he made that non-metallic globular inclusions wrought steel have the advantage over wrought steels with elongated non-metallic inclusions.

Literature

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