

Predicting structure micro-alloyed steel products for different purposes

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Annotation. The composition of micro-alloyed steels for controlled blanks forging of the auto important parts and for the products operating at lower temperatures is predicted. It was found that the use of steels, micro-alloyed with vanadium and nitrogen, vanadium, aluminum and nitrogen are useful for controlled forging blanks of the auto critical parts and as a cold-resistant steels for use in Siberia and the Far North.

The alloying element in the steel is capable of changing its grain size, display (bring out) unwanted impurities (in particular, to react with the oxygen, arsenic or sulfur being there and, harmfully effecting a metal alloy), to raise the hardenability, heat resistance and other properties [1, 2].

Under microalloying we understand the small additives of elements or their compounds added to the composition of the alloy that enhance its properties through the local doping of grain boundaries and subgrains and the formation of strengthening phases with sharply limited solubility of the latter in the α - γ -solutions. The term "small" additives depends on the alloy composition and the solubility of the impurity in its main component [3].

Slightly different chemical elements are used in microalloying than in conventional doping. Those are reactive substances - zirconium, boron, tungsten, niobium, aluminum, and vanadium, titanium, and others. Typically Al, Ca, Mg, B, Ba, and N; and refractory metals (Zr, Ti, Nb, V), rare earths metals (Ce, La, Y et.) and their mixtures (mischmetal, ferrocerium) [4] are used for microalloying.

Billets of crucial parts in mechanical engineering are usually manufactured by hot plastic deformation (forging, stamping, rolling and etc.) as the deformable metal has a significant advantage in their properties, compared with a cast condition. Furthermore, for such items it is recommended to use steels with carbon content in the range 0.3-0.5%, alloyed with chromium, nickel, molybdenum and vanadium. However, these steels have a drawback - they are expensive and prone to overheating at temperatures of hot stamping or forging (1100-1200 ° C). There is a significant grain growth during heating the chromium-nickel steel. Steels alloyed with vanadium and titanium are less prone to overheating (Figure 1).



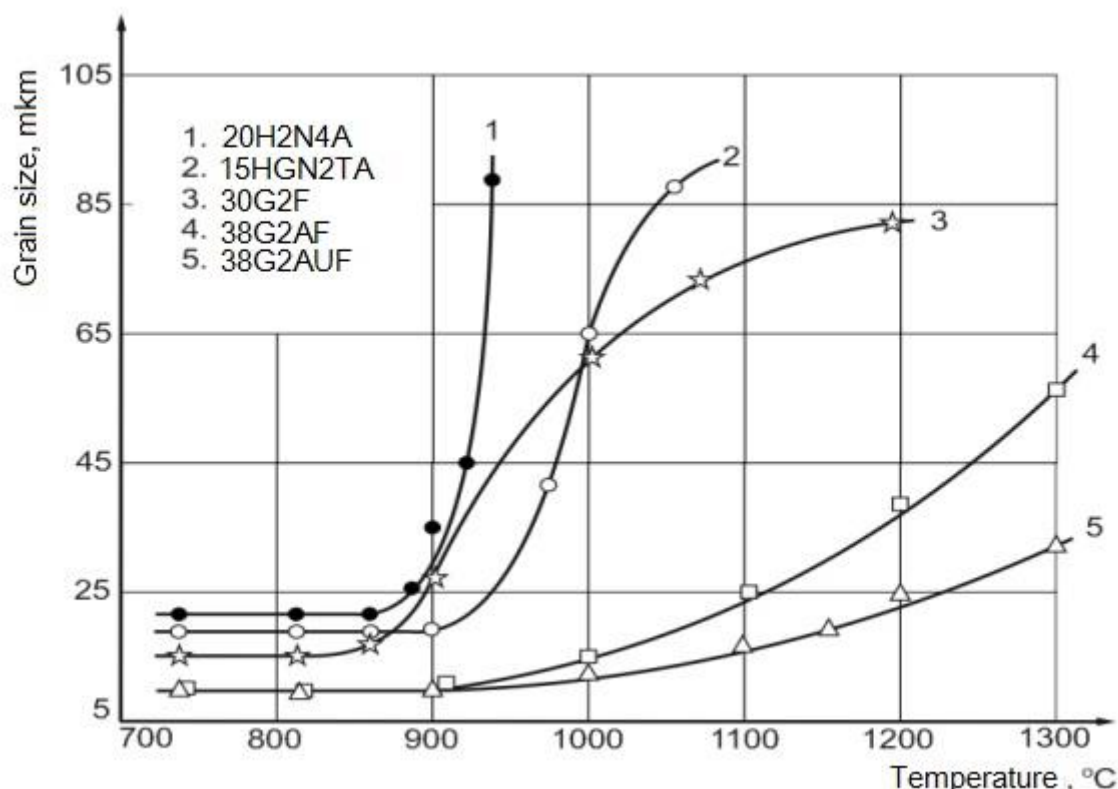


Fig. 1 - Temperature dependence of the grain growth in the steel.

One of the ways to solve these problems is steel microalloying with vanadium, aluminum, nitrogen [5, 6]. With all-inclusive introduction of these complex elements we have maximum technological and economic benefits. The slight grain growth occurs in such steels (Figure 1, curves 4 and 5) even at temperatures of hot plastic deformation beginning (1100-1200 °C). Steel high resistance to overheating is due to the formation of aluminum nitrides and nitrides of vanadium, which are located along the grains boundaries and hinder their growth.

The positive effect of microalloying with vanadium steel, aluminum and nitrogen can be realized in the production of billets by hot stamping by the use of the residual heat for the heat treatment of forgings. Fine structure maintaining during deformation and subsequent postdeformation cooling eliminates the need for steel re-heating above the critical temperature intended for recrystallization, and accordingly makes it possible to exclude the operation of austenization during heat treatment.

Steel structure formation can be controlled and a given structure and properties of the alloys can be formed during the implementation of controlled deformation processes and billets cooling. The positive role of micro-alloying is observed in low-alloy steels used in the construction industry, the oil and gas industry and the railways [7, 8]. Steel grades 18F 15GF are successfully used in the manufacture of building structures. The use of these steels in certain construction projects saved up to 20% of rolled steel and reduced the cost of rental structures by 8-15%. The use of steel grade 09G2 12HGFD in the manufacture of semi-carriages (gondolas) made it possible to obtain significant savings by reducing weight, increasing the reserve maintenance periods and increasing the semi-carriages (gondolas) reliability. For the operation in the North low carbon steels (0.3% C) are used doping them with different elements. For a long time only nickel steel 3, 6 and 9% of nickel and low carbon content or austenitic chromium-nickel steels were used for these temperature operating conditions. For a moderately low temperatures low carbon micro-alloyed steels with low nickel

content up to 1.5% or even without it are recommended. Steel, micro-alloyed with vanadium and nitrogen (grade 15G2AF), has a high cold resistance with considerable strength that allows us to recommend it for the manufacture of large diameter pipes for trunk pipelines, working in the conditions of the North. Thus, the use of steel, micro-alloyed with vanadium and nitrogen, vanadium, aluminum and nitrogen are useful for controlled blanks forging of the auto critical parts and as cold-resistant steels for operating use in Siberia and the Far North.

References

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