BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

UDK 669.017: 620.18

THE EFFECT OF THE TEMPERATURE OF PRE-QUENCHING AND TEMPERING ON THE CHANGE IN THE DISLOCATION DENSITY OF LOW-ALLOY AND HEAT-RESISTANT STEELS.

Mamarasulov Rasuljon
Namangan State Technical Univeersity.
mamarasulovrasuljon1992@gmail.com

Abstract: The features of structure formation during high-temperature hardening of low-alloy and heat-resistant steels are investigated. The new evidence obtained proves the possibility of achieving a good combination of structure formation and achieving certain dislocation densities. Rational modes of non-traditional heat treatment are determined.

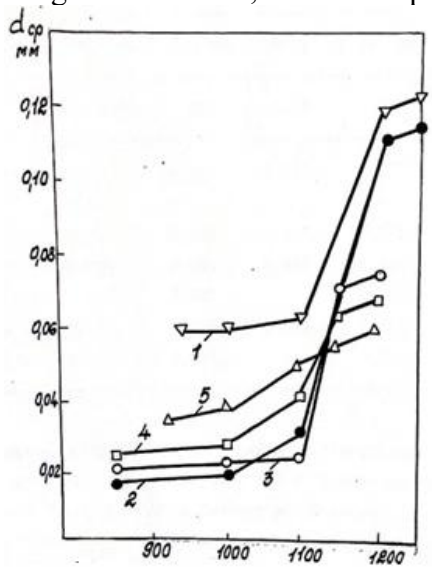
Keywords and expression: structure, structured and phase conversions, re crystallization, density not perfection, defects of the construction, parameter of the structure, fart crystallization, dispersion, thermal history

INTRODUCTION

When choosing the technology of thermal prehistory, high-temperature quenching will be the most appropriate. Compared to normalization, this process looks to be the most productive and requires less decarbonization, as exposure time to air at high temperatures is reduced.

As already described, heating at high temperatures was carried out in salt baths. Most of the experimental results were obtained earlier on carbonaceous and low-alloy structural steels, as well as low-alloy tool steels [1]. However, a systematic study is possible when obtaining comparative data obtained under the same experimental conditions. Therefore, the following data are provided not only for heat-resistant steels, but also for iron of various purity, steel 40X and SHX15.

The study of the microstructure of steel hardened at various heating temperatures shows the well-known fact of the growth of austenitic grains and the increase of martensite plates. All steels, including technical iron, have a sharp increase in austenitic grain, above 1100 °C.



Pre-quenching temperatures, °C

Fig.1. Change in the austenitic grain size of steel depending on the heating temperature during quenching. 1- armco-iron, 2- 40X steel, 3- 5KHNM, 4- D5, 5- 4KHMFS.

The only difference is that the absolute value of the austenitic grain size is significantly lower in alloy steels (Fig.1).

This indicates that the main barrier to the growth of austenitic grains are refractory, insoluble phases such as aluminum nitrides and carbonitrides and oxygen-containing phases [2].

METHODOLOGY AND MATERIALS

Carbides of alloying elements such as Cr, Mo, and V also dissolve in austenite at elevated heating temperatures and inhibit the growth of austenitic grains. However, in all cases, heating above 1100°C leads to a sharp increase in grain.

The microstructure of the studied steels was martensite of various morphologies, depending on the composition of the steel and the tempering temperature. The structure of all medium-carbon steels 40X, 5KHNM, D5, 4KHMFS is a massive (dislocation) martensite. With an increase in the temperature of heating for quenching, an increase in the length of the rails and plates of martensite is observed, as well as an increase in the residual austenite (Fig. 2).



а



б



с

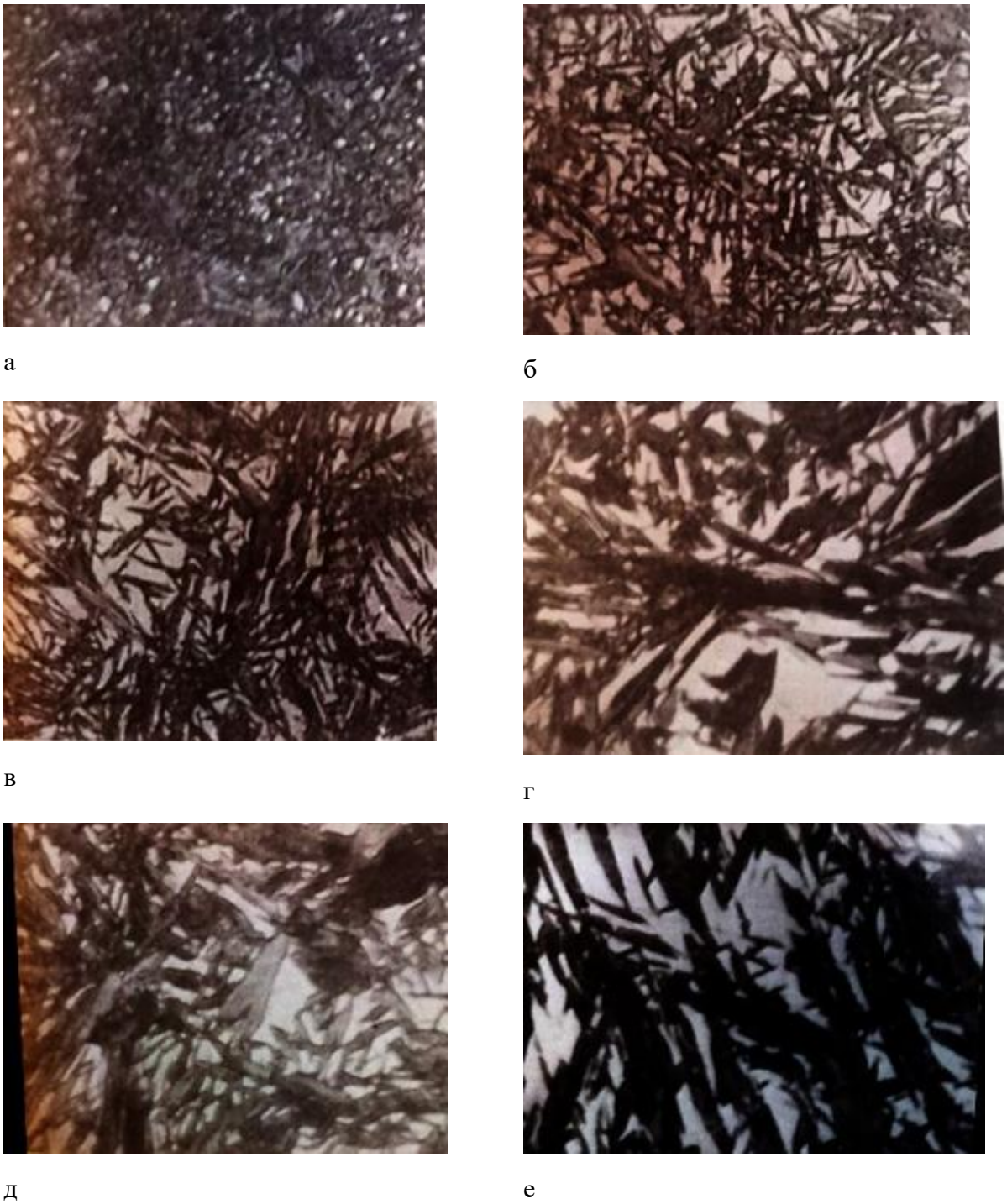


д

Fig.2. Microstructure of 4HMFS steel after preliminary heat treatment: quenching a) 930 °C, b) 1100°C, c) 1150°C, e) 1200 °C, x 600.

In the microstructure of high-carbon steel SHX15, after quenching at 840 ° C, very finely needle-like rack-and-pinion martensite and excess carbides are observed. With an increase in the quenching temperature and an increase in the solubility of carbides, the structure of twin martensite and residual austenite is observed (Fig. 3).

All the studied steels have an extreme heating temperature, when a structure with a maximum dislocation density is formed during cooling. For most carbon and low-alloy steels, the extreme temperature of the first phase recrystallization is 1100°C.



а б в г д е

Fig. 3. Microstructure of steel SHX15 after preliminary heat treatment: quenching a) 840 °C, b) 900°C, c) 1000°C, d) 1100°C, e) 1150 °C, f) 1200 °C, x 1000.

After accelerated cooling of this temperature, an increased level of defects in the crystalline structure of the α–phase is observed [3]. The reason for this could be the phase cleavage and recrystallization of austenite during the α–γ transformation and the subsequent investigation of defects in the crystalline structure during the reversible γ–α transformation.

However, experiments on high-temperature X-ray diffraction, when analyzing the line width (311) It has been shown that the recrystallization of austenite under furnace heating conditions is completed at temperatures well below 1100°C.From [4].

RESULTS AND DISCUSSION

Experiments on heating technical iron samples in high vacuum revealed several vacuum drop peaks: 280-310, 510-600, 1100-1120 °C. The first two peaks were attributed to degassing of the surface and surface layers, and the third peak, at 1100-1120 °C, was associated with the dissociation of refractory impurity phases, mainly carbon-nitride and oxygen containing.

Since the beginning of the dissolution of these phases is characterized by the chemical microuniformity of the solid solution (austenite), with accelerated cooling, an increased level of defects in the crystalline structure of the α–phase is formed. This is due to the formation of zones with different periods of the crystal lattice and, in connection with this, the formation of a block structure with the development of semi-coherent boundaries with mismatch dislocations [5].

If the heating temperature is significantly lower than the extreme temperature, then austenite homogenization occurs and, upon cooling, the defectiveness of the α–phase lattice is lower.

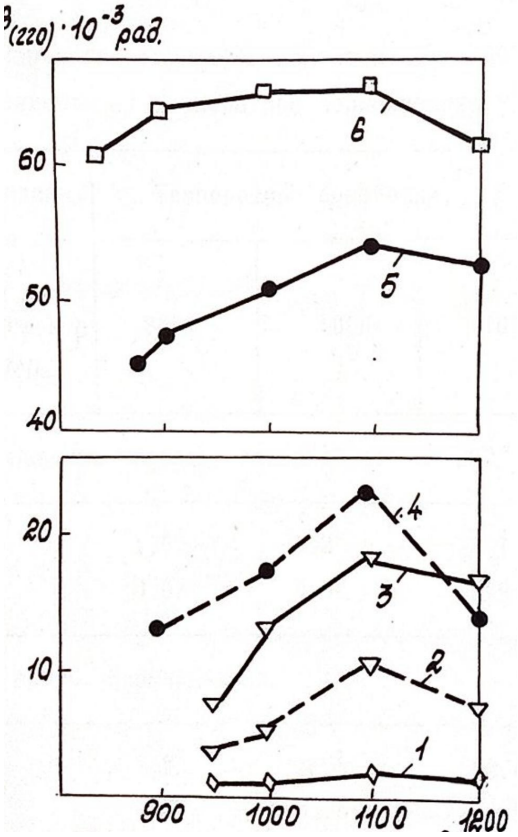


Fig. 4. Change in the physical width of the Rengen interference line (220) depending on the quenching temperature: 1-high purity iron, 2.3–technical iron (armco-iron), 4.5–steel 40 X, 6- WX15, 1, 3, 5, 6 – quenching, tempering 200 ° C, 2, 4–normalization.

Our experiments also showed that for iron and low-alloy steels, the experimental temperature corresponds to 1100 °C (Fig. 4), but for heat-resistant steels it is 1150 °C (Fig. 5).

As can be seen from Fig. 4, the extreme heating temperature is clearly observed for 40X and 40X15 steel and steel, when a structure with a maximum dislocation density is formed during cooling. The graphs show a change in the physical broadening of the Rengen interference line (220) as a measure of imperfection of the crystal structure. The peak of the maximum crystal structure of the α–phase is observed both during quenching and during normalization.

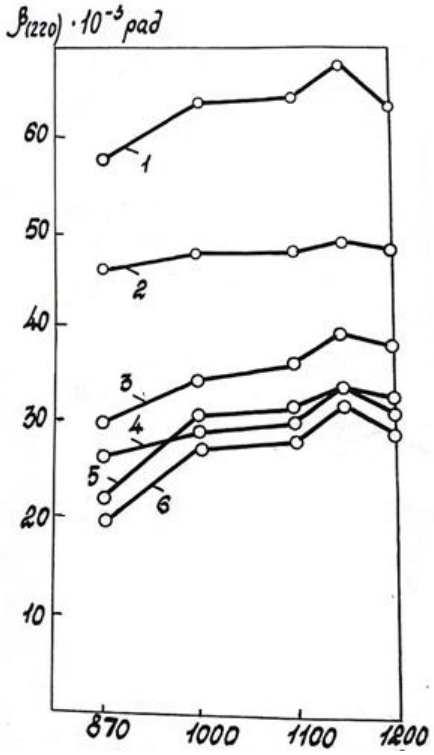


Fig. 5. Change in the physical width of the X-ray interference line (220) depending on the quenching temperature: 1-high purity iron, 2.3–technical iron (armco-iron), 4.5–5KHNM steel, 1-tempering 240 ° C, 2-350 ° C, 4-500 ° C, 5-550 ° C, 6-600 °C.

The very low values of the physical width of the X-ray line (220) in high-purity iron indicate in favor of the concept of the influence of impurity insoluble phases on the formation of a maximum defect in the crystalline structure.

Of all the low-alloy steels and jellies considered, steel SHX15 has the least pronounced peak (see Fig.4). This is due to the fact that the level of defects in the crystalline structure of the α–phase is affected by the dissolution in austenite of not only refractory phases, but also the dissolution of secondary carbides. Therefore, after cooling, the peak of the defect level of the a–phase crystal structure becomes less pronounced.

In all studies of heat-resistant steels hardened at various temperatures, there is also a pronounced peak of the maximum defect in the crystal structure (Fig.5). However, this peak occurs at 1150°C. An increase in the tempering temperature of 5KHNM, D5, 4KHMFS steels tempered from different temperatures does not lead to a peak shift in the temperature range of heating for quenching.

CONCLUSION

From this it can be concluded that in these steels, the dissolution of all carbides at a temperature of 950-1000°C is completely completed, and the formation of an extreme should also be associated with the dissolution of refractory impurity phases. Technologically, the most appropriate way to prepare the thermal background of low-alloy and heat-resistant steels is quenching with intermediate tempering. At the same time, there are extreme heating temperatures for quenching, for low-carbon steels 40X, SHX15 - 1100 ° C, for heat–resistant steels 5KHNM, D5, 4KHMFS-1150°C, when after cooling, a structure with a maximum density of alpha-phase dislocations is formed.

References.

[1]. A.M. Kalitin, V.D. Sadovsky. Structural inheritance in cemented alloy steels. Volume. 1966. No. 2. pp. 7-11.
[2]. A.A. Mukhamedov. Investigation of properties after recrystallization of steel. Vol. 1972. No. 12. pp. 14-20.
[3]. Ya. Rakhimov, Z. Abdukakhkhorov, Structured conversion become under different type of the termal processing. “International Conference on Advance Research in Humanities Sciences and Education - 2022” online from New York, USA on Februare 28 th 2022
[4]. Ya.Rakhimov, Z.Abdukakhkhorov, The effect of thermal treatment with repeated heating on the properties of materials of working mechanisms of agricultural machines. Sustainable development of science and education. Scientific and Practical Journal 2022. No. 2.
[5].Ya.Rakhimov, Z.Abdukakhkhorov. Influence of the history of thermal processing on the mechanical properties of metals, FerPI-Journal of scientific technology, 2022. №4. 51-55