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INFLUENCE OF QUENCHING TEMPERATURE AND TEMPERATURE ON THE STRUCTURE FORMATION OF STEEL R6M5

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ABSTRACT

This article presents the result of studies of the influence of modes hardening for structural components of die tool steels. Shown ambiguous influence of high-temperature hardening on the growth of austenite grain will prolong the retained austenite.

Keywords— austenite, martensite, hardening, dislocation.

INTRODUCTION

When steels are heated above the phase transformation point, there are extreme temperatures from which, upon cooling, a structure with the maximum defectiveness of the crystal structure is created. The extreme heating temperatures for tool steels are 1100-1200 °C.

This is due to the dissolution of impurity refractory phases, as well as the beginning of the dissolution of special carbides. When these carbides dissolve, areas of uneven alloying appear, which, upon cooling, creates additional dislocations between micro volumes. The heating temperature for hardening high-speed steel R6M5 reaches 1230°C. At this temperature, the carbides do not completely dissolve in the solid solution. At low heating temperatures of 950-1000°C, carbide M dissolves$_{23}$C6, and at 1200 °C the main carbide M6C dissolves. First of all, M6C carbides, containing more chromium, but less tungsten, dissolve; at higher temperatures, M6C carbide dissolves with a large amount of tungsten.

However, even at a high heating temperature, most of the M6C carbides with a high tungsten concentration remain insoluble. Thus, the possibility of the existence of an extreme heating temperature for hardening in high-speed steels remains minimal, since any increase in temperature above 1230 °C leads to the additional dissolution of some more carbides and homogenization requires more time. It should also be noted that since R6M5 steel belongs to precipitation-hardening steels, the maximum increase in hardness up to HRC 65 falls on the tempering temperature of 550-560°C, with 2-3 times tempering.

Results and Discussion

To create a combined chemical-thermal treatment of high-speed steel R6M5, it was necessary to establish the most suitable hardening and tempering modes for carrying out the process of low-temperature nitrocarburizing. The essence of the combination was to combine the processes of tempering and low-temperature nitrocarburizing. To establish these modes of heat treatment, it was necessary to determine the main parameters of the steel structure. As in the case of die steels, studies were carried out on the effect of the hardening and tempering temperature on the parameters of the steel structure (physical width of the X-ray line, dislocation density, crystal lattice parameters, and hardness of R6M5 steel). The research results are shown in Figures 2-4.

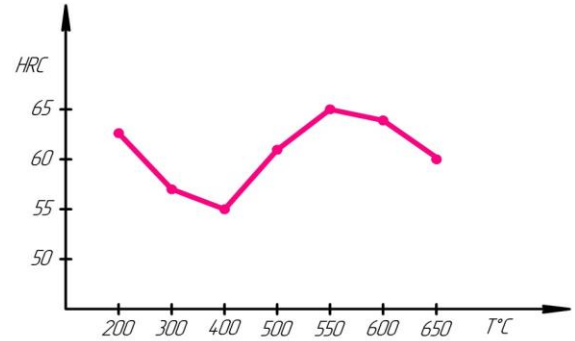

Fig. 1. The effect of tempering temperature on the hardness of steel R6M5. Quenching from a temperature of 1200 °C

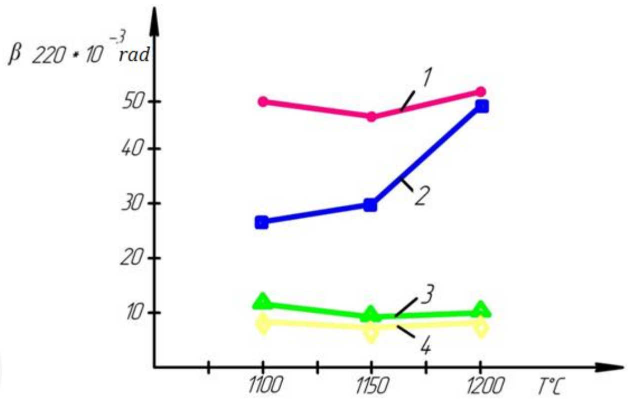

Fig. 2. The effect of the hardening and tempering temperature on steel R6M5, the width of the physical line β (220):

1 - tempering 560 °C, 2 - tempering 620 °C, 3 - tempering 700 °C, 4 – tempering 730 °C

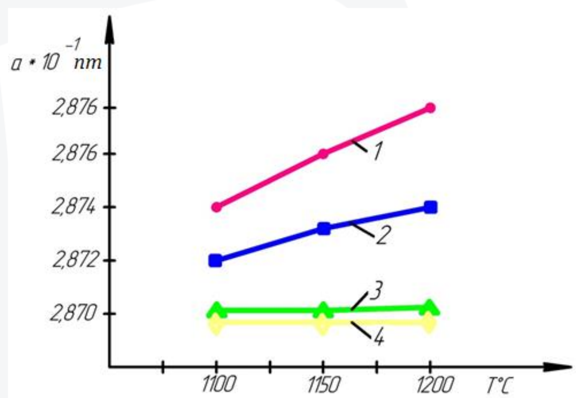

Fig. 3. Influence of the hardening and tempering temperature of steel R6M5 on the parameters of the crystal lattice:

1 - tempering 560 °C, 2 - tempering 620 °C, 3 - tempering 700 °C, 4 - tempering 730 °C

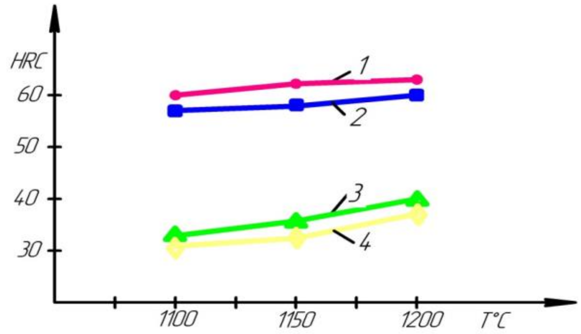

Fig. 4. The effect of the hardening and tempering temperature of steel R6M5 on hardness:
1 - tempering 560 °C, 2 - tempering 620 °C, 3 - tempering 700 °C, 4 - tempering 730 °C

Analyzing the above data on the effect of the hardening temperature on the parameters of the structure, we can conclude. That for steel R6M5 the extreme hardening temperature is the standard hardening from 1200-1230°C when, after hardening, the maximum dislocation density is formed. Also, the alloying of the solid solution is maximal, and softening during tempering is the smallest. It is known that at a sufficiently high heating temperature for hardening high-speed steels, the heating time for hardening has a strong effect on the size of the austenite grain. To determine the effect of the holding time for hardening steel R6M5 on the size of the austenite grain, studies were carried out separately (Fig. 5-6) on the effect of the size of the austenite grain on the holding time for hardening. As can be seen from Fig. (5-6), the growth of austenite grains can be avoided by reducing the holding time of the steel when heated to quenching temperatures. The introduction of accelerated and short-term heating changes the austenite grain size up to 12 points (dav ≈ 0.0055mm).

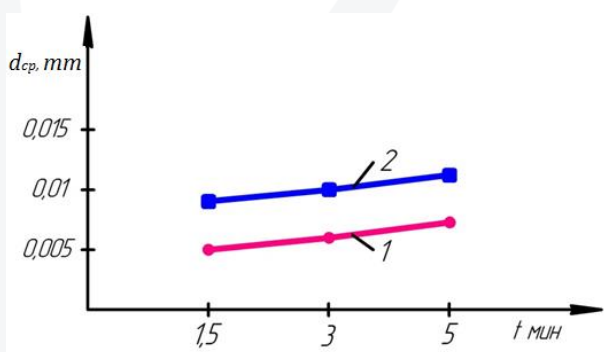

Fig. 5. Influence of holding time at a quenching temperature of 1200 ° C on the grain size of austenite of steel R6M5:

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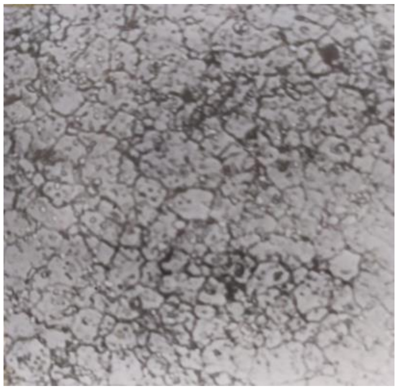
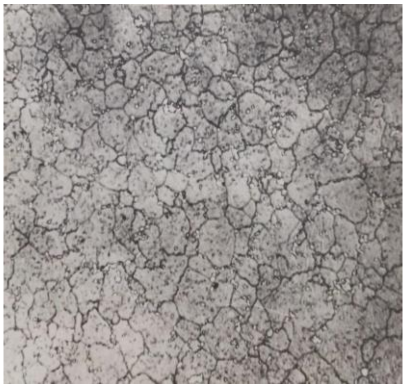
1 - tempering 560 °C three times for 1 hour, 2 - tempering 620 ° C single, 1 hour.



a) x 500



b) x 500

Fig. 6. The grain size of austenite steel R6M5 when quenched from 1200 °C:
a - exposure 1.5 min, b - exposure 5 min

CONCLUSION

In general, the structure of hardened high-speed steel consists of martensite retained austenite, and undissolved carbides of alloying elements. The subsequent tempering of the steel leads to a decrease in retained austenite and to the precipitation of finely dispersed carbides of alloying elements, which provide the steel with the required level of heat resistance. As a result of heat treatment of R6M5 steel, a complex structure is formed, the basis of which is tempered martensite interspersed with finely dispersed carbides, residual austenite, and inclusions of special carbides that are not dissolved during heating for quenching.

REFERENCES

1) V. A. Struk and others, “Materials science in mechanical engineering and industrial technologies”, M .: Publishing house "Intellect", 2010. -536 p.
2) G.P. Fitosov, “Materials science and technology of metals” - M .: Higher School, 2006 .-- 861p.
3) O.V. Chudnni, G.V. Gladova, “The choice of materials and methods of hardening of parts of transport engineering”, M .: MADI. 2015 .-- 118 p.
4) B.N. Arzamasov, “Materials Science: Textbook for Universities” - M .: MSTU named after Bauman, 2008 - 648p.
5) T.D. Babul, T.G. Kucharieva, “Influence of the initial structure and tool steels on the thickness and hardness of layers obtained as a result of carbonitriding”, MiTOM, 2004. No. 7 - P. 17-20.