УДК 621.785.78:669.14.018.8

Sharsneva D., Khomenko S.

The Influence of Alloying Elements on the Properties of Martensitic Aging Steels

Belarusian National Technical University
Minsk, Belarus

The basis of maraging steels is carbon-free iron-nickel martensite. Nickel increases the solubility of many substitutional elements in austenite, allowing the martensitic transformation to proceed slowly.

Unlike carbon steels, the hardening of maraging steels occurs due to the precipitation of fine particles of intermetallic phases at a temperature of 450–500 °C. The most common alloying system for maraging steels is Fe–Ni–Co–Mo–Ti.

Nickel contributes to an increase in the volume fraction of hardening phases released during aging, and thereby increases the efficiency of the precipitation hardening process. The positive effect of cobalt in maraging steels is also due to the formation of ordered regions in the martensitic matrix phase during aging, which are an additional strengthening factor. Chromium in maraging steels contributes to an increase in their corrosion resistance and at the same time causes additional hardening during aging.

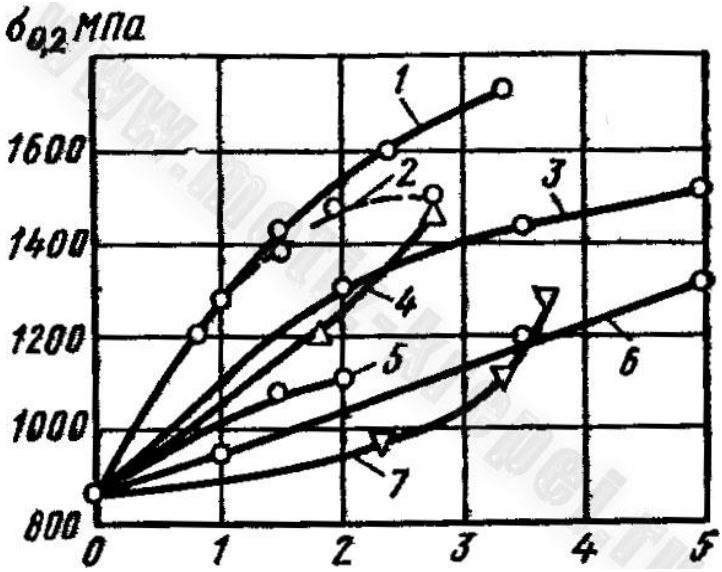

Fig. 1 - The Influence of the Concentration of Alloying Elements on the Hardening of Iron-nickel Martensite (18% Ni) during Aging: 1 - Ti; 2 - Be; 3 - Al; 4 - Mn; 5 - Nb; 6 - C; 7 - Mon.

Maraging steels contain, as a rule, a large number of different alloying elements. When choosing them, a strict balance of components is required, since in this case it is necessary to ensure not only effective precipitation hardening of martensite during aging, but also to prevent the appearance in the steel structure of a large amount of residual austenite, which reduces strength, or δ-ferrite, which reduces the ductility of steels [1].

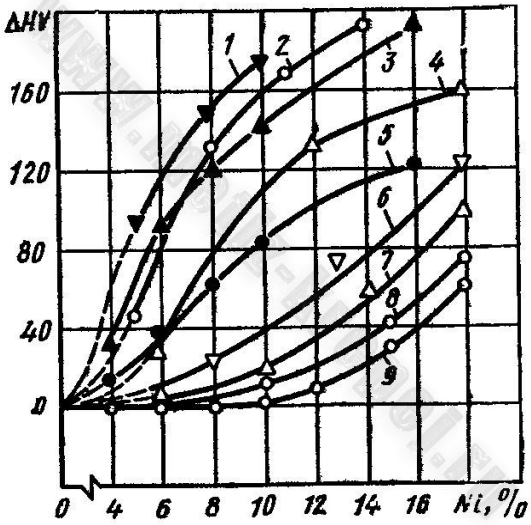

Fig.2 - The Influence of Nickel Content on the Increase in Hardness (ΔHV) during Aging of Martensite Steels Based on 2 Fe with Various Additional Alloying: 1-5% Mn; 2-4% niobium; 3-1.5% titanium; 4-6% Ta; 5-1.5% Al; 6-3% Si; 7-7% vol.; 8-10%B; 0-5% Mo;

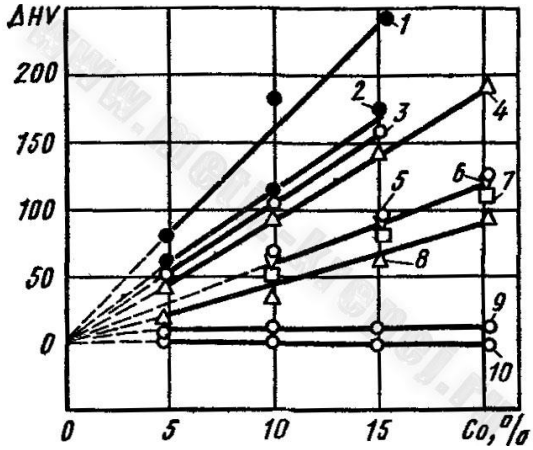

Fig. 3 – The Influence of Cobalt Content on the Increase in Hardness (ΔHV) during Aging of Iron-nickel Martensite (14-18% with Various Substitution Elements: 1-H18F7; 2-H18V10; 3-H16M5; 4-H16C3; 5-H14B4; 6-H18Ta6; 7-N16G5; 8-N16; 9-N16T; 10-N16Yu.

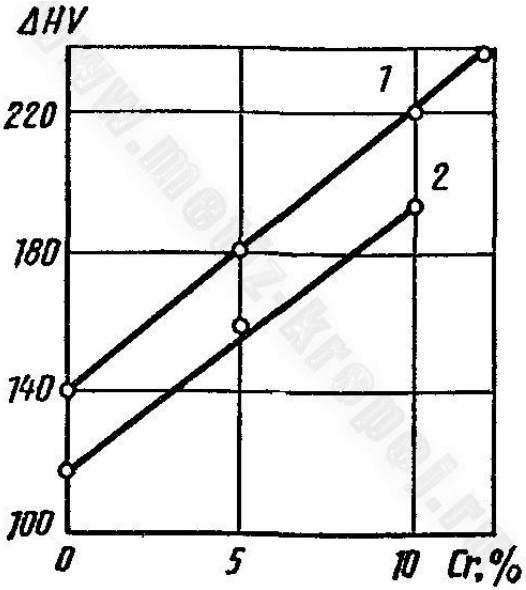

Fig. 4 - The Influence of Chromium Content on the Increase in Hardness (ΔHV) during Aging of Steels: 1 - Fe + 11% Ni + 1.1% Ti; 2 - Fe + 11% Ni + 1.1% Al

References:

1. Properties of high-alloy maraging steels [Electronic resource]. – Mode of access: https://thelib.info/mehanika/883610-svojstva-vysokolegirovannyh-martensitno-starejushhih-stalej/. – Date of access: 25.03.2022.