NEUTRON DIFFRACTION STUDY OF MARTENSITE TRANSFORMATION IN FE—NI—C ALLOYS

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The unique mechanical properties of iron-carbon martensite in the quenched and tempered state have stimulated numerous investigations of the martensite transformation mechanism and kinetics, the crystal structure of quenched martensite.

There are a few experiments confirming the change of the austenite state during martensite transformation, for example /1/, about the decrease of the Debye-Waller factor in retained austenite of the

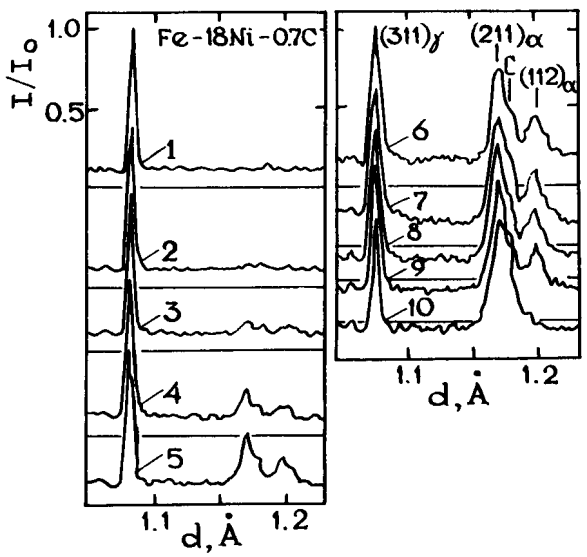

Fig. 1 — parts of the neutron diffraction patterns with $(311)_\gamma$ and $(211)_\alpha$, $(112)_\alpha$ lines of alloy Fe—18Ni—0.7C are shown. These curves were obtained in different temperatures during slow cooling from 20C(*1*) to —40C(*2*), —50(*3*), —60(*4*), —94(*5*), —143(*6*), —196(*7*). (Then sample was annealed at —50(*8*), 20(*9*), 100(*10*) ($T_{measuring}$ = =—196C)

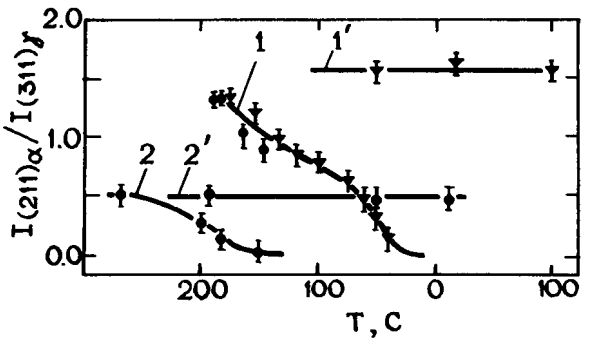

Fig. 2

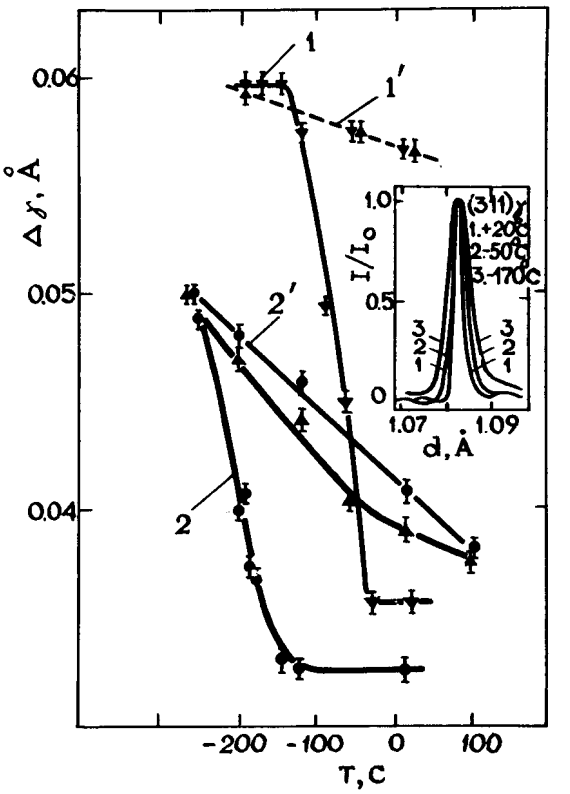

Fig. 3

Fe—N alloy. The main conceptions of the martensite transformation are the martensite nucleation as a result of the dislocation splitting and the initiation of transformation by the phonone modes of the lattice without a clear division in the martensite embryos and their growth.

In iron-carbon alloys martensite is a supersaturated solid of carbon in α-iron and the pecularities of its crystal structure are in most part determined by the character of the carbon atoms distribution.

In austenite carbon atoms are distributed in octahedral intersites and exposed to soft mutual repulsion.

Below the results of a high resolution neutron diffraction study of virgin and aged martensite in alloys Fe—Ni—C are presented and discussed.

Alloys Fe—18Ni—0.7C and Fe—2ONi-1.18C(wt%) were studied. The martensite transformation starting temperatures of these alloys were —20C and —170C correspondingly.

The measurements were conducted using the time-of-flight neutron diffractometer «Mini-SFINKS» /2/. This diffractometer permits the work to be done in a range of interplane distances $0.5<d<2.0$ Å with the resolution $\Delta d/d=(0.2—0.4)\cdot10^{-3}$ Å.

The first experiment involved a slow cooling of the sample from room temperature to —196C for some tens of hours with a run of neutron diffraction spectrum each two hours. Below —196C the sample was suddenly cooled to —269C. Then the sample was subsequently annealed at temperatures —196,—123,—50,20,100C. Neutron diffraction patterns were taken at —269C after each annealing (fig. 1).

In the second experiment we used fast cooling from room temperature to —196 or —269C.

The quantity of martensite phase could be estimated by the ratio of integrated intensities $I_{(211)_\alpha}/I_{(311)_\gamma}$ for Fe—20Ni—1.18C(1,1′) and Fe—18Ni—0.7C(2,2′) (fig. 2). It's known, that the temperature interval of the martensite transformation and the amount of martensite in these alloys are very different.

The austenite lines are broadened during martensite transformation (fig. 3). The change of a half-width $(311)_\gamma$ line for both alloys is shown in fig. 3. The widths of other austenite lines for Fe—18Ni——0.7C and Fe—20Ni—1.18C alloys are also different.

The width of the austenite lines considerably decreases in Fe—20Ni—1.18C alloy during heating from —269C and —196C to room temperature and it changes very slightly in Fe—18Ni——0.7C. These results concern strains during martensite transformation /3/.

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