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AN INTERNAL FRICTION PEAK DUE TO DEEP COOLING INDUCED MARTENSITE IN 18-8 TYPE STAINLESS STEEL

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Abstract - An internal friction peak associated with martensite induced at low temperature in 18-8 stainless steel was observed. The mechanism of the peak is considered to be the same as that for the Snoek peak in α-iron.

I - INTRODUCTION

There are many investigations on the internal friction peak which is considered to be due to stress-induced martensite in 18-8 stainless steels. However the internal friction behavior of the martensite induced by low temperature cooling in this steel has not been investigated sufficiently. In the present work, an internal friction peak associated with the martensite induced at low temperature was observed in 18-8 stainless steel. The objective of the work was to show that the relaxation phenomena were identical and Snoek peak was the same for both kinds of martensite, the stress induced martensite and the deeply-cooled martensite.

II - EXPERIMENTAL PROCEDURE

All of the steel specimens were heated to 1373K for 15 minutes and quenched into water. Some were then cooled to 77K for 30 minutes and some others were tempered at 473K for 120 minutes. Magnetic measurements were used to determine whether the γ-α transformation took place during deep-cooling. Internal friction was measured both by transverse vibration of thin rods at 500 Hz and with the torsion pendulum at 2.94 Hz.

III - EXPERIMENTAL RESULTS AND DISCUSSION

The internal friction curves measured by the transverse vibration technique are shown in Fig. 1. Curve "a" showed a peak at 360K for a specimen which had been cooled to 120K in the internal friction apparatus. A magnetic test showed that the γ-α transformation had taken place in the specimen after it had been cooled. On the other hand, no peak appeared in the internal friction measurement for a specimen which had not been cooled prior to the higher temperature measurement, curve "b". These results show that the internal friction peak at 360K for a frequency of 500 Hz is associated with the martensite induced by the prior cooling to 120K.

Similar results were obtained for measurements made in the torsion pendulum. No peak appeared for the specimen which had not been cooled below room temperature, Fig. 2, curve "a". Curves "b" and "d" in Fig. 2 show a peak at 300K for a frequency...
Fig. 1. Internal friction curves measured by transverse vibration method for the solution treated specimens.

a. measured from 120K
b. measured from 290K

Fig. 2. Internal friction curves measured by torsion pendulum method

specimens: a. solution treated, b. d-deeply cooled at 77K for 30 min. after solution treatment, c. aged at 473K for 120 min. after treatment as same as b and d.

measurement frequencies: a, b, c. 2.9Hz, d. 4.0Hz.
of 2.9 Hz and a peak at 306K for a frequency of 4 Hz, both for specimens which had been cooled to 77K for 30 minutes. Magnetic measurements showed that the γ-α transformation took place only for the specimens cooled to 77K. Therefore this peak is considered to be due to the low temperature induced martensite. Curve "c" shows that the peak disappeared for the specimen tempered at 473K for 2 hours.

The positions of these peaks can be used to show Arrhenius relationship between measurement frequency and position of the peak. That plot is shown in Fig. 3. One sees that the peaks for both types of martensite fall along the same Arrhenius line. The activation energy for the peak is 0.92 eV and the frequency factor is $6.3 \times 10^{15} \text{s}^{-1}$. Therefore both peaks must have the same origin. This peak is considered to be Snoek peak, because of the similarities of the activation energy and the frequency factor with measurements made for carbon in α-iron. It is also reasonable that the peak height increases with the total concentration of solute carbon and nitrogen, as shown in Fig. 4.

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