Temperature, stress, strain and the deformation induced martensite kinetics

The deformation-induced martensite reactions have been classified as stress-assisted and strain-induced [1]. The overall kinetics of the deformation-induced reactions has been described by different equations [2-4]. However, the isothermal nature of the reaction [2] raises some questions about the possible influence of the temperature (thermal energy) upon the overall kinetics of the deformation induced reaction. This matter is currently under investigation in this laboratory and the present note is a report of some relevant initial findings.

The alloy used was a Fe-30.7% Ni-0.06%C prepared for mechanical testing and metallography in the form earlier described [2]. Martensite volume fractions were measured by X-ray diffraction and by point counting after deep electro-polishing. No surface martensite was observed.

Different polycrystalline specimens were tensile tested at 25°C in an Instron TT-DM machine up to 25% nominal plastic strain ($\dot{e} \simeq 3 \times 10^{-4}$ sec^{-1}) and either unloaded or kept under the maximum applied load for different amounts of time. It was observed that the reaction proceeded isothermally under the constant load condition but not after unloading. The pertinent kinetics data are given in Table I. The metallographic observations of the unloaded specimen and that under constant load for 4h, (Fig. 1) indicated that the morphology of the martensite plates in both cases was essentially the same. This is an indication that no special change in the actual transformation mechanism resulted from changing the usual tensile test into a constant-load at room temperature.

TABLE I

Time (h)	Martensite vol. fraction (%)
0*	7
1	24
4	32

*Unloaded.

Therefore, strain, load and temperature (thermal energy) seem to be altogether important factors for the reaction kinetics. Work is in progress in order to correlate and explain these effects.

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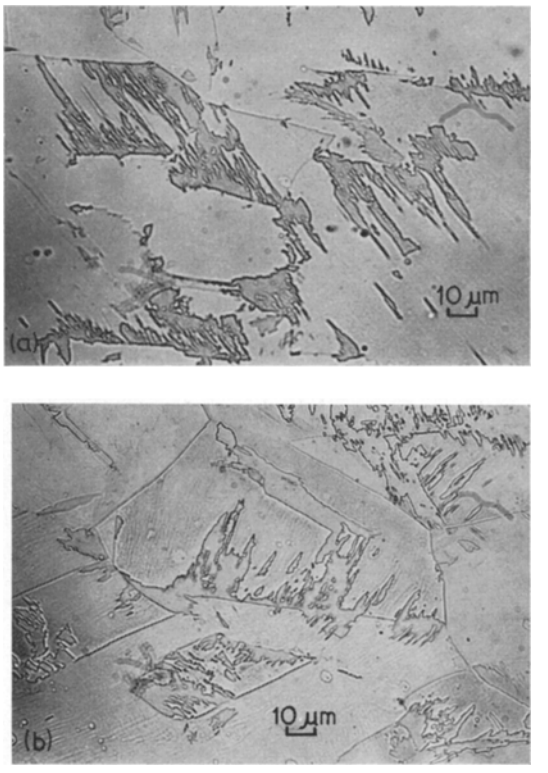

Figure 1 Optical photomicrographs. Microstructure observed in a specimen deformed 25% and (a) unloaded and (b) kept 4h under load.

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J. R. C. GUIMARÃES
L. M. BIHARI
A. SAAVEDRA
Instituto Militar de Engenharia,
Pça. Gen. Tibúrcio s/n – Rio de Janeiro, Brazil

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