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MECHANICAL STABILIZATION OF AUSTENITE AGAINST ε MARTENSITE AND ITS EFFECT ON DEFORMATION BEHAVIOR IN HIGH MANGANESE STEELS

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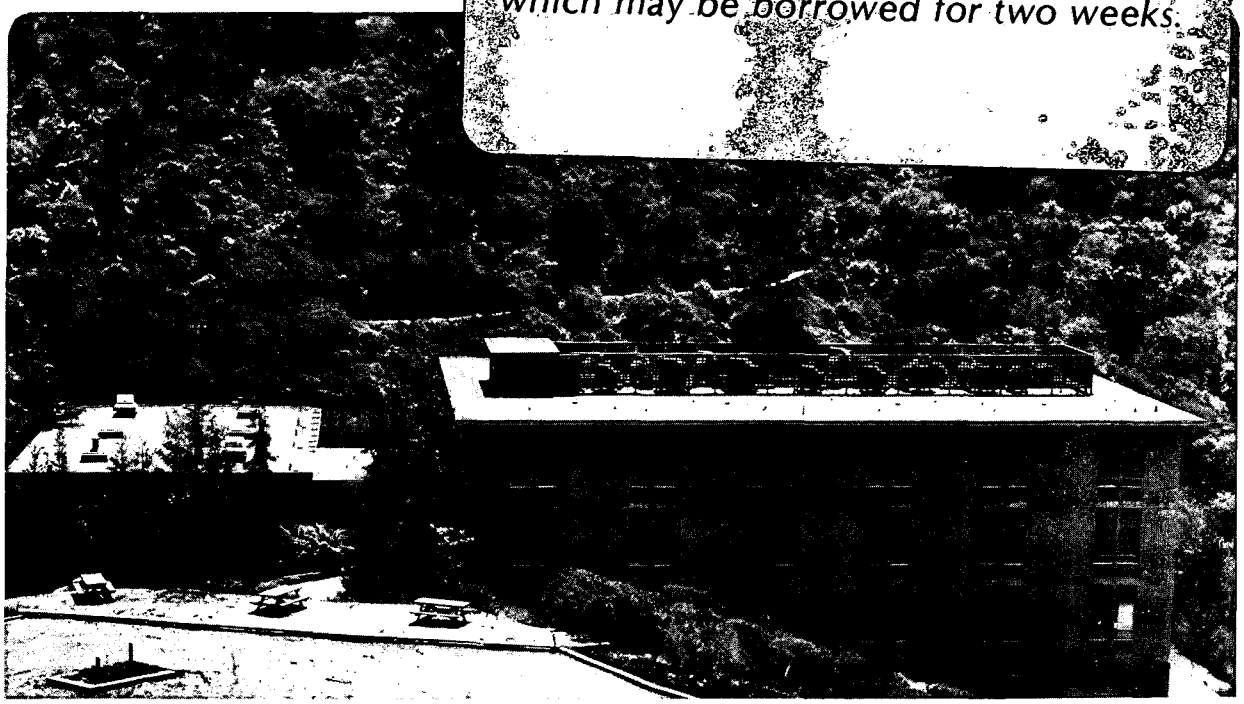

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MECHANICAL STABILIZATION OF AUSTENITE AGAINST ε MARTENSITE AND ITS EFFECT ON DEFORMATION BEHAVIOR IN HIGH MANGANESE STEELS

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INTRODUCTION

The ε martensite phase is known to be induced by deformation in several commercially developed high Mn steels. These steels are usually strengthened by C and/or N and show excellent combination of strength and toughness at cryogenic temperatures [1]. However, because the role of ε formation during deformation in these steels has not yet been clarified, fundamental investigation should be focused on this point. In Fe-17 and 25% Mn binary alloys, ausforming is found to be very effective in stablizing austenite, although the influence of grain size (austenitizing temperature) on the amount of ε at RT is small. Ausforming consists of dislocation introduction above the ε_D tmperature by rolling. The influence of ε-formation on flow curves of the austenite strengthened by dislocations (ausformed) is different from that of the solution-treated plate.

EXPERIMENTAL PROCUEDURE

The cold rolled 17 and 25 wt% Mn alloys previously described [2] were solution-treated at 1000° for 1 h followed by water-quenching. They were heated to 400°C and rolled to about 30% reduction in thickness (ausformed). The plate tensile specimens with 0.125 by 0.150 in (3.2 by 3.8 mm) cross section and 1 in (25.44 mm) gage length were cut along the rolling direction.

RESULTS AND DISCUSSION

The TEM microstructure of ausformed 25 Mn is shown in Fig. 1 where small amounts of ε martensite are observed in the γ matrix with a high density of dislocations. The volume fraction of ε is too low for measurement by x-ray techniques.

Figure 2 shows stress-strain (displacement) curves. The comparison of tensile properties between ausformed and non-ausformed austenite is shown in Fig. 3.

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At 200°C where austenite is stable, strength is increased by ausforming while elongation drops. However, at RT and -196°C, about 50% ε generation increases elongation (TRIP) but decreases the yield strength of the ausformed material. This means that the stress for the onset of ε-formation becomes smaller than that for plastic flow (slip). This causes decreased yield strength as the temperature is lowered due to the ε formation. It was also found that shape recovery (memory) by the ε -> γ transformation occurs to some degree when the deformed specimen is heated to 250°C. Therefore, the shape change of the specimen is considered to be partially due to the γ -> ε transformation.

Contrary to the 25 Mn alloy, α' martensite is also induced with ε in the 17 Mn alloy during deformation at LNT. The flow curve is characteristic of strain-induced α' formation, as can be seen in Fig. 2. A very low workhardening region exists at the early stage of plastic flow followed by high work-hardening.

ACKNOWLEDGMENTS

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REFERENCES

1. For example, H. Yoshimura, et al., Trans. ISIJ, 22 (1982) p. 577. R. Ogawa and J.W. Morris, Jr., Proc. of ICMC, Kobe, Japan (1982) p. 124.
2. Y. Tomota and J.W. Morris, Jr., Spring, 1984, Iron and Steel Society Meeting, Japan.

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Fig. 1. TEM microstructures of ausformed austenite in 25 Mn steel.

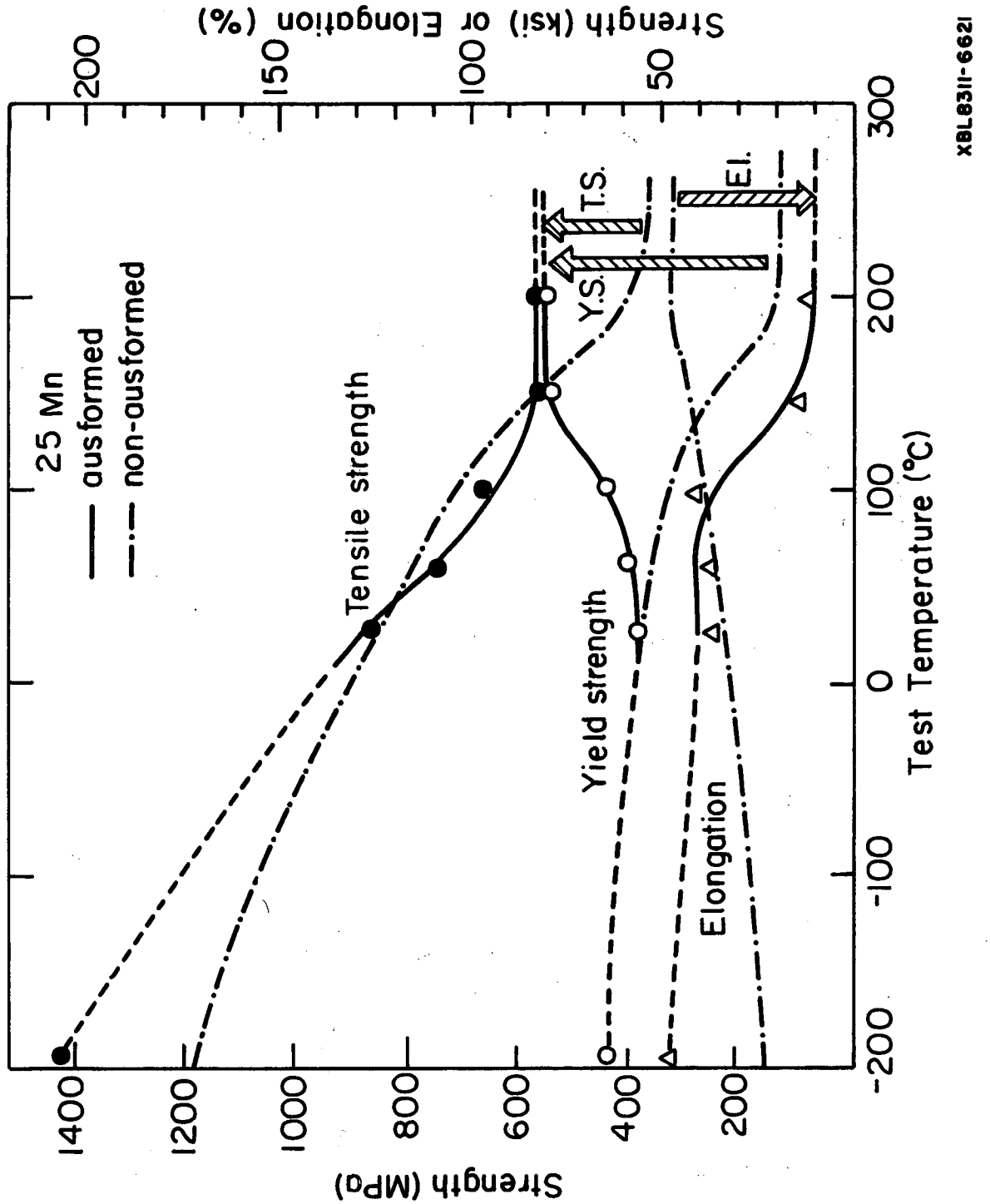

Fig. 2. Comparison of tensile properties of ausformed and non-ausformed 25 Mn steel.

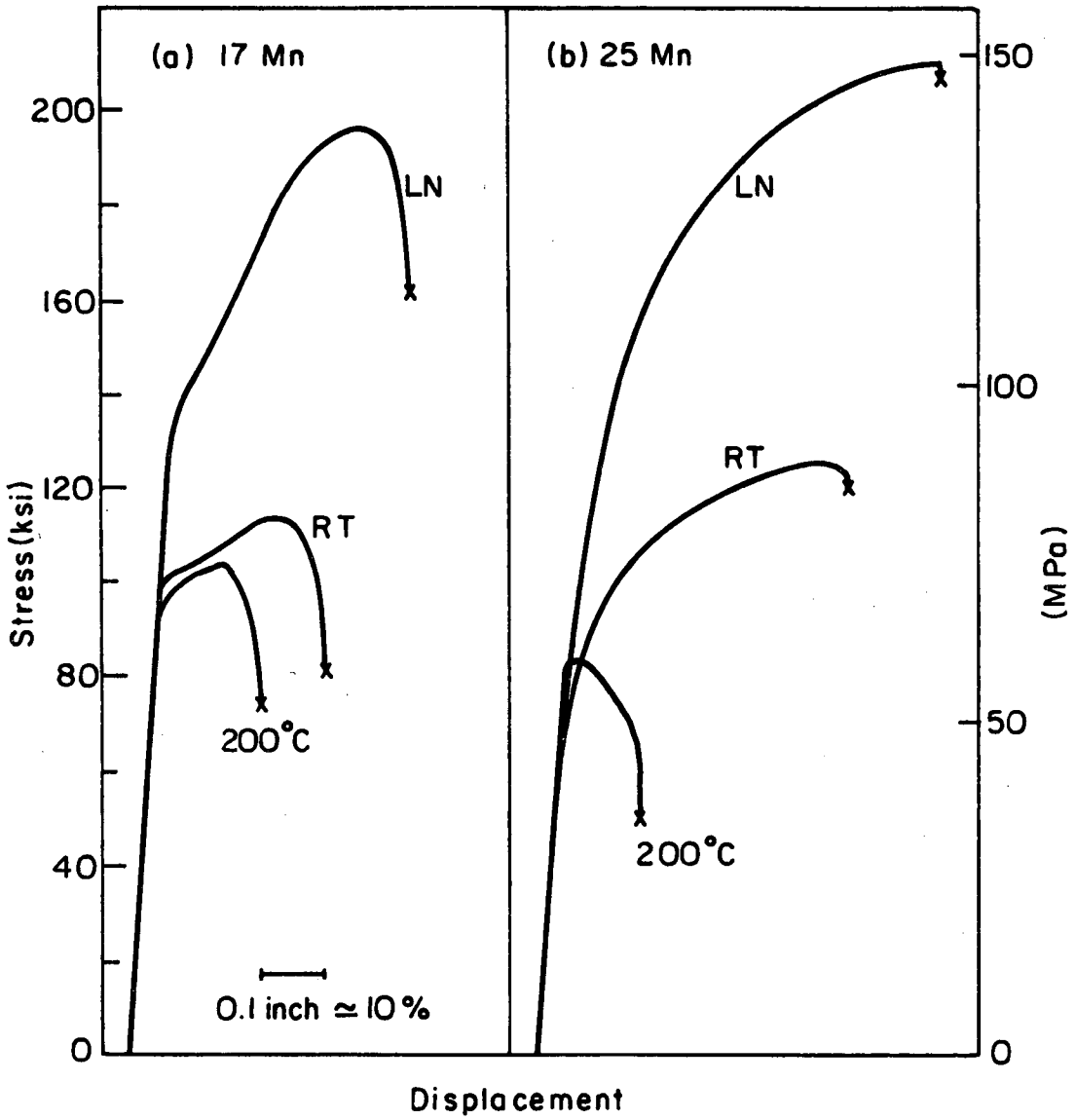

Fig. 3. Flow curves at various temperatures: a) in 17 Mn and b) 25 Mn steel.

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