Scripta METALLURGICA Vol. 4, pp. 437-440, 1970 Pergamon Press, Inc.
Printed in the United States

SHOCK INDUCED MARTENSITIC TRANSFORMATIONS IN BCC Fe-Mn

A. Christou*

Materials Science Division

U. S. Naval Weapons Laboratory

Dahlgren, Virginia

(Received April 2, 1970)

1. Introduction

Recent experiments have shown that BCC α-iron transforms to a close-packed phase under shock pressures[1,2]. The effect of dynamic pressure produced by intense shock waves on the pressure volume relations was first studied by Bancroft, Peterson and Minshall[3]. The nature of the high pressure phase which must form and revert in the order of 10^{-6} seconds has not been established. Static experiments however, have shown that in pure iron, at room temperature, the high pressure phase is hexagonal close packed ε [4,5].

The addition of alloying elements to iron modifies the temperature pressure diagram, and the stability of the γ or ε fields can be increased by the addition of manganese. Consequently, the shock loading of the Fe-Mn alloys which have been subzero quenched to form α-martensite (α'), results in a pressure induced $\alpha'\rightarrow\gamma$ transformation for the Fe-7.37 wt % Mn alloy and $\alpha'\rightarrow\epsilon$ for the Fe-14 wt % Mn alloy. It is the object of this paper to report the morphology and crystallographic features of the α' to γ and α' to ε transformations.

2. Experimental Methods and Results

The Fe-Mn alloys were austenized for five hours at 950°C and then quenched to 77°K. This subzero quench produced 86% α-martensite in the alloys. Foil specimens of the alloys, 3 cm by 3 cm were shock loaded to peak pressures of 90, 150 and 300 kb using the driver plate technique[6]. Thin foils suitable for transmission electron microscopy were prepared from

* Work supported by ARPA and NWL independent Research funds.

materials before and after shock loading. Surface trace analysis was used to find the habit planes of the transformed regions, and orientation relations were determined by electron diffraction.

The Fe-7.37 Mn specimens shock loaded to 90 kb had plates of γ transformed from α-martensite. Tilting of the specimen showed that the γ bands were not remnants of the martensite. The γ plates were surrounded by deformation twins in the martensite and were associated with screw dislocations lying on the $\{110\}_M$. At 150 kb, the plates observed were internally twinned on {111} planes, and it is believed that the internal twins are associated with an inhomogeneous shear in the $\alpha' \rightarrow \gamma$ transformation. These internal twins were similar to those observed by Bowden and Kelly (8) in Fe-Ni. At 300 kb, extensive transformation occurred.

Single surface analysis was employed to determine the habit plane for a particular variant of the orientation relationship. The angle between the habit plane and the foil normal was calculated using the foil thickness values (2500 A°) and the projected width of the α habit plane interface. In this way, the position of the habit plane normal on the great circle was determined via single surface trace analysis.

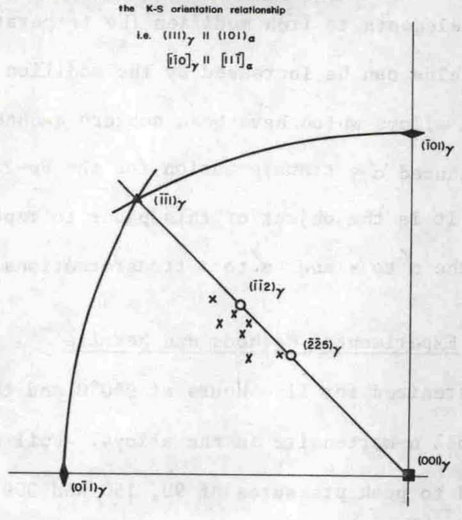

FIG I

Stereographic projection of habit planes observed at 90 kb.