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CORRESPONDENCE

Susceptibility and Saturation Magnetization Measurements in Shock-loaded Iron Manganese

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Abstract

It is shown that shock waves at pressures of 90, 150, 300 kbars have a notable effect on the magnetic properties of FeMn (92·4/7·6 wt. %). In increasing fields (up to 30 kilo-oersteds) three regions including the Barkhausen effect have been identified. The reduction in magnetization ΔM produced by shock loading can be represented by $\Delta M = q/H + p/H^2$, where q depends on the applied stress. In addition, susceptibility measurements indicate a shock-induced Curie transformation.

Work-hardening and the existence of high densities of dislocations have a notable effect on properties of magnetic materials. Studies by Kronmüller (1959) and Friedel (1956) have related the reduction in magnetization to plastic deformation. Dektyar and Levina (1962) have explained the increase of the critical field H_c with work-hardening. The effects of shock waves on the residual magnetic properties of armco iron have been investigated by Rose, Villere and Berger (1969). However, changes in saturation magnetization and susceptibility have never been observed in shocked material.

It is the purpose of this correspondence to report the results of our magnetization and susceptibility studies in shock-loaded FeMn (92·4/7·6 wt. %). We have related our experimental results to the effect of work-hardening and magnetic transformations.

Proper heat treatment of the alloy FeMn resulted in a two-phase structure (α and martensitic α') prior to shock loading. The increase of the total free energy due to shock loading at pressures between 90 and 150 kbars has induced a martensitic transformation ($\alpha \rightarrow \epsilon$), and has caused a demagnetization transition to take place. We were not able to determine the exact pressure of the transformation, but we believe this pressure to be about 110 kbars. Density measurements of the shock-loaded specimens clearly indicate that the high pressure phase has been retained. A density change of 3·79% has been measured for specimens shocked at 150 and 300 kbars.

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