It is well known that β-brass orders so rapidly that a water quench cannot freeze in an appreciable amount of disorder. The β-brass investigation showed that an alloy initially furnace cooled from above the critical temperature resulted in a density change of 2.0×10^{-4} g/cm^3 at 300 kb, while shock deformation of an alloy quenched from above the critical temperature resulted in density change of 4.0×10^{-4} g/cm^3. The density change of the quenched β-brass alloy prior to shock loading was measured after the decay of the Clarebrough internal friction peak.(5) Metallographic examination of shocked β-brass did not reveal any martensite formation. It is therefore possible that the density changes shown in Table II for the furnace cooled specimens are due to the annihilation of microcracks by dislocations of opposite sign to those originally initiating the cracks. Some mechanical disordering was produced by shock deformation at 300 kb, as was made evident by X-ray diffraction measurements. At 300 kb, the superlattice lines showed some broadening with no corresponding change in the broadening of the fundamental lines. X-ray diffraction data (Table II) has led us to the conclusion that the high pressure phase in β-brass was not retained. Any shock-induced martensite that formed must be reversible. Our results agree with the work of Reynolds.(6) We may also speculate that only the disordered β-brass is metastable to deformation. Plastic deformation must therefore initially disorder the alloy and subsequent subzero temperatures trigger the transformation. However, when β brass is recovered to room temperature reversion takes place.

TABLE II

Density Changes and X-Ray Diffraction Results in β-Brass

Heat Treatment	Shock Pressure (kbar)	Density Ratio†	Major Lines
A	90	1.0002	BCC
	150	1.0003	BCC
	300	1.0004	BCC
B	90	1.0003	BCC
	150	1.0003	BCC
	300	1.0005	BCC
C	90	0.9998	BCC
	150	0.9998	BCC
	300	0.998	BCC

† Density ratio = $\frac{\text{Shocked Density}}{\text{Unshocked Density}}$

Heat treatments prior to shock loading: A = Subzero quench from 500°C, B = Subzero quench from 460°C, C = slow cooled from 500°C.

It is noted that the density changes in shock deformed Fe-Mn are approximately 10^4 times greater than those of β brass.

It is evident that Fe-Mn in a metastable BCC configuration behaves in a different manner from β brass. The temperature-pressure diagram for iron alloys shows a triple point, and the stability of the high pressure phase has been increased by the addition of manganese. Consequently, we have been able to retain the high pressure phase after the occurrence of the well known polymorphic transition which occurs in many iron alloys. In contrast to Fe-Mn, β-brass which was given the same type of heat treatment prior to deformation must depend on room temperature stabilization of thermo-elastic martensite. In conclusion, the experimental findings of this work show that shock deformation of quenched Fe-Mn alloys with composition of 4 wt. pct. Mn to 14 wt. pct. Mn results in a shock induced phase transformation with the high pressure phase retained upon relief.

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