1.2. *Ordering Reactions Induced by Shock Waves*

Ordering reactions under shock pressures have only recently received attention. The effects of shock waves on the alloy Cu_3Au have been determined by Beardmore, Holtzman and Bever (1964). These investigators subjected specimens of the alloy Cu_3Au in the ordered and disordered states to shock pressures in the range from 160 to 475 kbar. In the pressure range from 290 to 370 kbar. the degree of long-range order in the ordered alloy decreased sharply. Disordered Cu_3Au under explosive loading behaved in a manner characteristic of FCC solid-solution alloys. Furthermore, measurements of x-ray diffraction on Cu_3Au have confirmed the substantial destruction of long-range order at shock pressures greater than 290 kbar (Mikkula 1966). The destruction of LRO occurs over a limited interval of strain and is in contrast with conventional deformation in which disordering occurs at an approximately uniform rate with increasing strain.

Much more work remains to be done on the effect of shock deformation on the ordering kinetics for metals which undergo short-range and long-range order. In addition, there is lack of understanding of shock-induced changes that take place in ordered alloys. For example, the rapid change of resistivity of ordered Cu_3Au alloys at pressures between 290 and 370 kbar, corresponding to transient strains of 0·18 to 0·21, is indicative of the rapid decrease of order and is not understood at present. The purpose of the present investigation is to determine the effects of shock deformation on K-state formation in two alloys of Ni-Cr (22 and 30 wt. % Cr). Shock-induced changes in the ordering kinetics will be explained from the point of view of the effect of vacancies and deformational defects on the ordering process.

§ 2. Experimental Details

Ingots of Ni–Cr were prepared both by arc melting and by induction melting. The induction-melted ingots appeared microscopically to be much cleaner than the arc-melted ingots which contained a considerable amount of inclusions as well as gross regions of inhomogeneity. In the preparation of the induction-melted ingots, carboynl nickel was melted in an MgO crucible under vacuum and then hydrogen treated. The hydrogen was pumped out, 1 atmosphere of argon admitted, and 99·99% pure chromium was added. The melt was then poured under an argon atmosphere into a copper mold. Ingots 2 in. in diameter by 5 in. long, made by this process contained 22·2 and 30·3% by weight chromium. The ingots were then hot rolled into thin foil. The chemical composition of the alloys used in the present investigation is given in table 1. The Ni–22 Cr alloy contained carbon $< 0{\cdot}002$ and oxygen $< 0{\cdot}007$ wt. %. The Ni–30 Cr alloy contained carbon $< 0{\cdot}001$ wt. %.

Table 1. Chemical composition of the nickel–chromium alloys

Alloys	Chromium wt. %	Nickel wt. %
Ni–22 Cr	22·20	87·79
Ni–30 Cr	30·35	69·64

The Ni–22 Cr alloy contained carbon $<0{\cdot}002$ and oxygen $<0{\cdot}007$ wt. %. The Ni–30 Cr alloy contained carbon $<0{\cdot}001$ wt. %.

The specimens used in the quenching and deformation study were in the form of metal strips 3 mm wide, 25 mm long and 1 mm thick. All heat treatments were performed in quartz capsules evacuated to 10^{-5} mm Hg. The specimens were prepared in four initial heat treated conditions:

1 The heat treatment of the as-received material of 4 hours at 1250°C, followed by water quenching, was designed to provide alloys in a condition that closely approximated a random solid solution.

2 Additional specimens were annealed at 1250°C for 4 hours and then furnace cooled. This heat treatment allowed the alloys to approach equilibrium, which is the ordered state.

3 The as-received alloys were furnace cooled from 1250°C to room temperature then water quenched from temperatures between 50 and 1250°C.

4 A final set of specimens was water quenched from 1250°C, followed by isothermal annealing at 350°C for 3 hours.

The ordering kinetics for specimens in the 1 and 3 heat treated conditions were determined by resistivity techniques. The isothermal annealing temperature as well as the peak quench temperature were varied for each alloy. Specimens for resistivity analysis had four contact leads spot welded onto each end of the specimen, an outer pair through which the current was introduced and an inner pair across which the potential drop was measured.

Alloys in the 1, 2 and 4 heat treated conditions were shock loaded at 90, 200 and 300 kbar. Shock deformation was accomplished with the flying plate technique (Duvall and Fowles 1963). In this technique, the driver plate thickness controls the magnitude and geometry of the pressure pulse. The pressure obtained from each shot is determined by adjusting the explosive height, and the driver plate thickness. The pulse duration was maintained constant at 2 μsec. The shock loading assembly had been designed so that lateral motion during relief was prevented, and so that a reflected wave could not reach the specimen.