UNIVERSITY OF DENVER
COLORADO SEMINARY

Denver Research Institute
University Park, Denver 10, Colorado

13 July 1960

TID-6294

U. S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois

Attention: Mr. Steven V. White, Director
Research Contracts Division

Subject: Contract No. AT(11-1)-742

Gentlemen:

This informal letter report is the second of a series of monthly letter reports for the contract year, 1 May 1960 to 30 April 1961, describing the progress made on the research program, "Study of Factors Influencing Ductility of Iron-Aluminum Alloys," Contract No. AT(11-1)-742.

The objective of the program is to study the effects of heat treatment, composition, grain structure, interstitial content, and surface preparation upon room temperature ductility of iron-aluminum alloys; and to correlate these tensile properties with order-disorder structures by means of yield strength determinations and resistivity and X-ray techniques.

It is estimated that approximately 15 percent of the proposed research has been completed during the first two months of the contract period.

Isothermal Heat Treatment Studies

It was pointed out previously that there is a strong likelihood of the formation of a "foam-type" structure in a highly ordered Fe_3Al composition. On the assumption that this type structure does exist, isothermal annealing at or near the critical temperature would seem to offer a means of disrupting or disordering the existing domains and, in effect, produce domains of varying size.

During the past month, a series of isothermal heat treatments was carried out on highly ordered 13.6-Alfenol. The ordering treatment consisted of slow cooling (60°/hr) from 650C to 300C, holding at 300C for 32 hours, and

DISCLAIMER

air cooling. A resistivity specimen of ordered 13.6-Alfenol, in a recrystallized condition, was isothermally annealed at several temperatures. Resistivity measurements were made immediately upon placing the specimen into the heated zone. The resulting curves are shown in Fig. 1. Curves 1 and 2 were obtained by slow cooling and slow heating, respectively, and are included for comparative purposes. A small amount of hysteresis between the cooling and heating curves is evident.

It was expected that the resistivity vs. time curves would assume a shape such as No. 6, whereby the degree of order decreases rapidly at first and then gradually levels out at the equilibrium value for the given temperature. This type of curve was obtained only for 400 and 480C. For the higher temperatures of 500 to 560C an unexpected rise in resistivity was noted to occur before leveling off at the equilibrium values. The equilibrium resistivity was slightly higher in the instance of the 480 and 500C curves than indicated by the slow cooling and heating curves. This can probably be explained by the oxidation of the specimens that takes place upon repeated heating.

One possible explanation for the unexpected shapes of the curves for the higher temperatures could be the effect of hysteresis as higher heating rates are employed. This seems to be borne out by the fact that the resistivity rise for the 560C curve is almost instantaneous, reaching the region of the hump on the equilibrium curves at a very rapid rate. The initial high resistivity perhaps indicates a transient quasi-disordered state, which if retained, could considerably aid the room temperature ductility. This possibility will be explored more fully during the next report period.

The isothermal heat treatment studies will be continued during the next month. It is anticipated that the construction of the tunnel furnace will be completed and the warm rolling of the material on hand finished during the next report period.

Respectfully submitted,

Frank C. Perkins

Frank C. Perkins
Research Metallurgist

Joseph F. Nachman

Joseph F. Nachman
Manager, Alloy Development

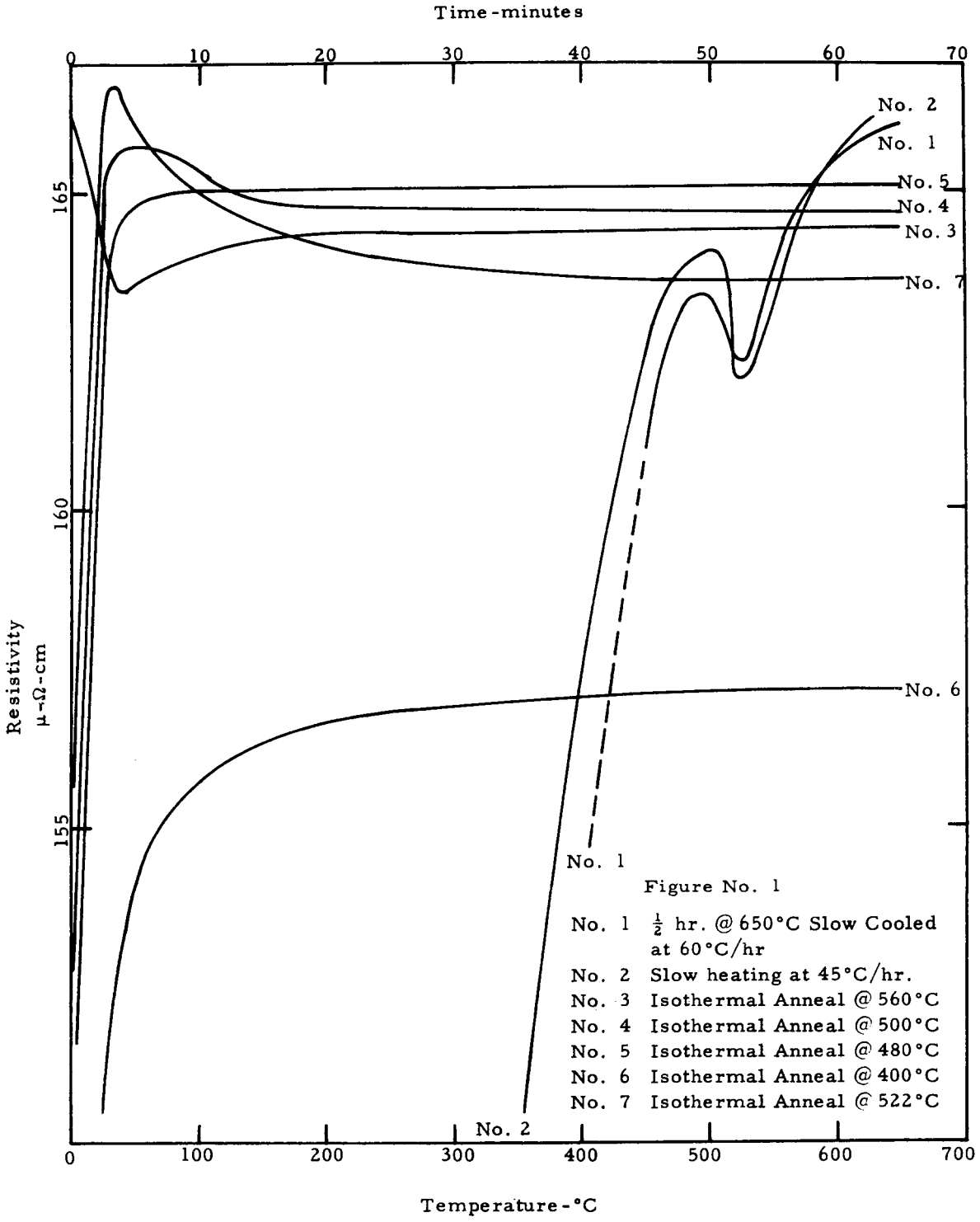

Figure No. 1

No. 1 $\frac{1}{2}$ hr. @ 650°C Slow Cooled at 60°C/hr
No. 2 Slow heating at 45°C/hr.
No. 3 Isothermal Anneal @ 560°C
No. 4 Isothermal Anneal @ 500°C
No. 5 Isothermal Anneal @ 480°C
No. 6 Isothermal Anneal @ 400°C
No. 7 Isothermal Anneal @ 522°C