EFFECT OF CERTAIN LESS COMMON ALLOYING ELEMENTS ON THE MECHANICAL PROPERTIES OF IRON-ALUMINUM ALLOYS

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Considerable attention has been paid recently to iron-aluminum alloys. These alloys have a number of valuable physical and mechanical properties, which qualify them for use as constructional materials. Among such properties are good high-temperature performance, low specific gravity, high hardness, good corrosion resistance and the possibility of making paramagnetic materials.

A special feature of the iron-aluminum constitutional diagram (Fig. 1) is the existence in annealed alloys of ordered solid solutions and the intermetallic compounds Fe₃Al and Fe₅Al [1-6]. The ordering and disordering of solid solutions is accompanied by changes in all physical properties.

The magnetic transformations in this system are closely connected with the existence of order [5, 7, 11-13]. Alloys of iron with about 16% of aluminum have been used as magnetic materials, replacing austenitic steels containing cobalt and nickel [8, 9, 14, 15].

The effect of adding titanium, silicon, vanadium and molybdenum on the mechanical properties of iron-aluminum alloys has been studied [8, 14] and the
alloy Alfenol with 16% aluminum and a ternary alloy with 3% molybdenum (Ter-
menol) [9, 15] have been developed and used as magnetic materials for laminated
transformer cores and jet compressor blades.

Iron-aluminum alloys with a high (about 16%) Al content that show a room
temperature elongation of more than 3% have not been produced as yet. This
brittleness is evidently due to the large proportion of nonmetallic inclusions
(alumina) in the alloys, the considerable amounts of impurities in the iron used
for making the alloy and the formation of chemical compounds and superlattices.
The tendency of these alloys to form many microcracks caused by their low
thermal conductivity, and their susceptibility to grain growth also act as embritt-
ling factors.

Because of the great importance of the iron-aluminum system, it seemed to
us interesting to check experimentally what scope there is for improving the
mechanical properties of these alloys with some of the less common elements.

Raw Materials and Method of Preparing the Alloys.
The starting materials for preparing the alloys were electrolytic iron,
(99.58% Fe, 0.013% Mn, traces of Si, 0.02% C, 0.02% S, 0.0022% P) and 99.99%
aluminum. The effects of zirconium, titanium, tantalum, columbium, vanadium,
boron, molybdenum and cerium were studied. The additions were selected to
include deoxidizers (Zr, Ti etc.), inoculants (Ce, B, V) and carbide-formers
(Ti, Cb, V). The composition of the alloys is in Table 1.