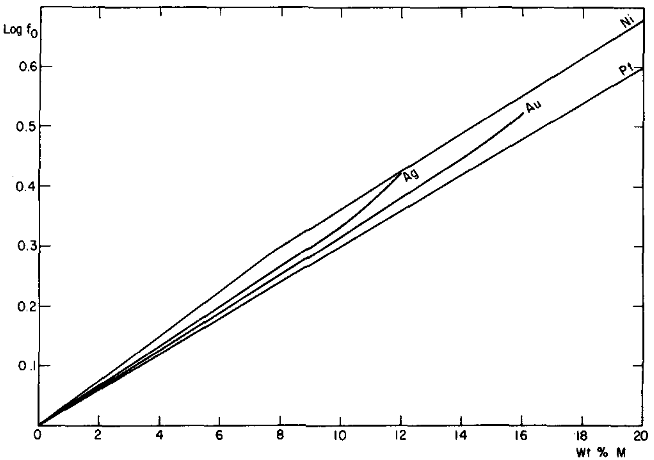

Fig. 7—Log f_0 vs wt pct M.

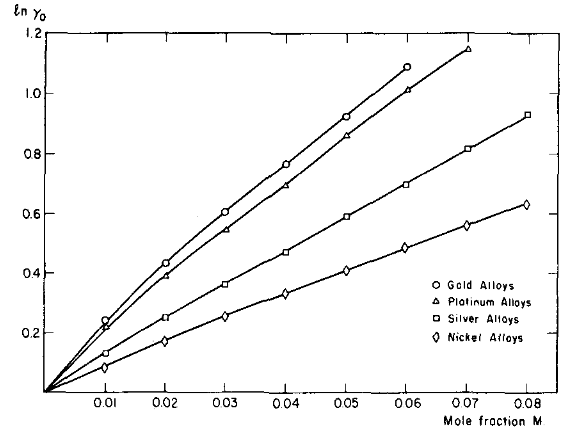

Fig. 8—Ln γ_0 vs $N_{\underline{M}}$.

Table I. The Interaction Coefficients at 1200°C

$e_0^M = \partial \log f_0/\partial \% M$; $\epsilon_0^M = \partial\, \ell n\, \gamma_0/\partial N_M$

Alloying Element	e_0^M	ϵ_0^M Calculated*	ϵ_0^M
Gold	0.0318	20.6	23
Platinum	0.0300	19.1	21
Silver	0.0335	12.4	13
Nickel	0.0375	8.0	9

*Using the formula given in Ref. 2, see Eq. [1].

perature conditions. On the other hand, it was expected that nickel would probably increase the oxygen solubility showing a negative e_0^M, because it is considerably less noble than copper. This was not found, however, and possibly can be explained as being due to nickel decreasing the activity of free electrons on the assumption that oxygen undergoes ionization upon dissolution according to

$$\tfrac{1}{2}O_2 + 2e^- = O^= \qquad [2]$$

The nickel atoms, having an incomplete d-orbital, can perhaps capture some electrons, thereby reducing their activity in the solution. Such reduction in the electron activity would—according to Eq. [2]—decrease the solubility of oxygen and therefore a positive ϵ_0^{Ni} would be observed.

Tankins, Erthal and Thomas[3] have investigated the system Cu-Ni-O over the entire composition range between pure copper and pure nickel. Their results showed that ϵ_0^{Ni} at 1550°C = -4.26 and ϵ_0^{Ni} at 1500°C = -3.91 which indicates that ϵ_0^{Ni} increases rapidly (becomes less negative) as the temperature decreases. A linear extrapolation based on such rate of change would predict that ϵ_0^{Ni} at 1200°C may be close to zero or even positive as found in this work. With alloys rich in nickel the same researchers[3] found that the addition of copper to nickel increases the oxygen solubility which is opposite to what might be expected on the basis of nobility consideration alone but perhaps in line with the "electron capture" theory cited above.

ϵ_0^{Ag} calculated from the results of Fruehan and Richardson[4] near 1200°C is about 4.6 which is less than the value of 13 found in this work. There is no explanation at this time for the difference.

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Relationship between Alpha Grain Size and Crack Initiation Fatigue Strength in Ti-6Al-4V

J. J. LUCAS AND P. P. KONIECZNY

DURING the course of investigating the effects of processing variables and heat treat conditions on the mechanical properties of Ti-6Al-4V, a general relationship was observed between α grain size and the high cycle (10^8) fatigue strength for both smooth (K_t = 1.0) and notched (K_t = 1.8) specimens. This relationship is presented in Fig. 1. Limited data on solution treated and aged (STA) Ti-6Al-6V-2Sn is also presented. The finer α grain sizes have been obtained in the barstock and in the STA forging materials and these materials exhibit the higher fatigue strengths.

All material test specimens were oriented in the longitudinal direction of the test material and were longitudinally polished as the final surface preparation. Testing was conducted under axial loading at ambient temperature conditions with a +45 Ksi steady tensile stress. Constant load type test machines operating at 1800 cpm were utilized. The mean fatigue strength determined for each material condition was based on the results of 8 to 10 tests.

α grain size was determined by examination of longitudinal sections of typical test material on an optical microscope. At least 25 values of α grain diameter

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J. J. LUCAS and P. P. KONIECZNY are Supervisor, Materials Development, and Materials Engineer, respectively, Sikorsky Aircraft, Div. U.A.C., Stratford, Conn.

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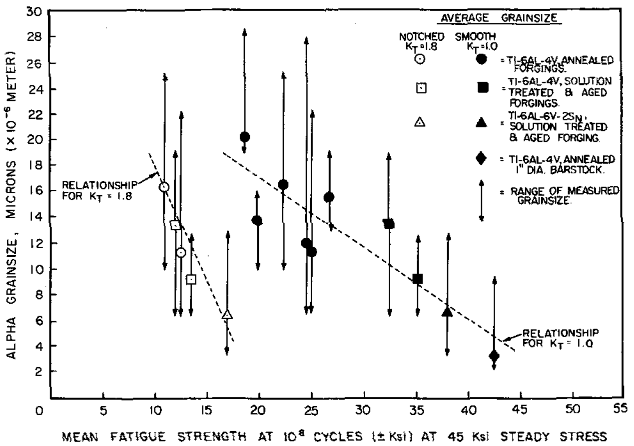

Fig. 1—Relationship between α grain size and crack initiation fatigue strength.

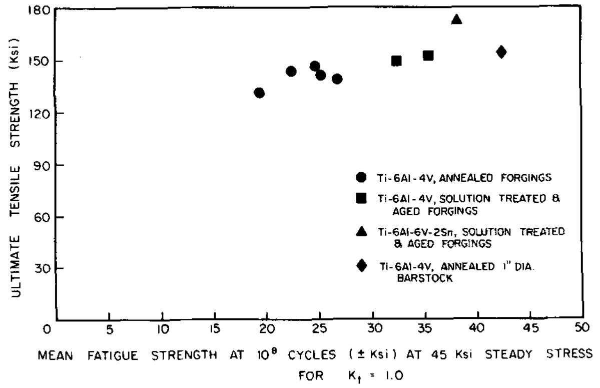

Fig. 2—Relationship between ultimate tensile strength and crack initiation fatigue strength.

were made by a random intercept method for each sample. The range of measured values and the mean value obtained are shown in Fig. 1.

Similar results on the effect of grain size on fatigue strength have been previously observed in steel alloys[1] and in commercially pure titanium[2] and although other variables were present in our tests such as the basic chemistry and percentage primary α, the present evidence indicates processing methods which result in finer α grain sizes should be further investigated to improve the fatigue strength of titanium components.

Fig. 2 presents a comparison of the ultimate tensile strength of these materials to the smooth specimen fatigue strengths. Although the fatigue strength tends to increase with tensile strength, the percentage increase in fatigue strength is abnormally higher than the corresponding increase in tensile strength. For instance, although there was only a 17 pct difference in tensile strength, greater than a 2 to 1 difference in fatigue strength was obtained between the lowest strength Ti-6Al-4V forging material and the highest value which was for the barstock.

Because of the small differences in tensile strength and large differences in fatigue strength observed in this material it does not appear reasonable to reliably predict fatigue strength on the basis of tensile test values. In contrast with these results, previously reported data for steels,[3] aluminum alloys,[4] and Ti-6Al-4V[5] indicate a reasonable correlation between tensile strength and fatigue strength.

Since tensile strength cannot be used as a consistent indication of fatigue strength in Ti-6Al-4V, microstructure controls such as grain size may prove to be necessary quality assurance requirements for obtaining repeatable fatigue strength. It is therefore important to further substantiate and quantify the observed effect of grain size on fatigue strength reported herein.

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Self-Diffusion Data of Metals and Stable Electronic Configuration Model

G. S. UPADHYAYA

In a recent paper Sharma and Ray[1] have attempted to correlate self-diffusion data with the Engel-Brewer theories of metals and alloys. In the present communication an attempt is made to study the mode of variation of the self-diffusion coefficient of metals on the model of stable electronic configuration, proposed by Samsonov.[2,3]

During the formation of a solid, the valence electrons can be divided into localized and nonlocalized parts.[4-6] This proposal has been experimentally verified by X-ray spectroscopy of some transition metals[6-10] and also by Hall constant data.[11] In the further development of this approach it was proposed[2,3,12,13] that the localized fraction of the valence electrons form a fairly broad spectrum (statistical collection) of configurations in which the maximum statistical weight is possessed by the energetically most stable electronic configuration corresponding to the minimum state of free energy. Such stable electronic configurations for d-metals are d^0, d^5, and d^{10} and according to the degree of descending energy stability, these can be arranged in the order d^5-d^{10}-d^0. An analogous picture is also observed for f-elements, the atoms of which can form stable f^0-f^7 and f^{14} configurations with f^7 having the maximum stability. Assuming that for transition metal atoms in the free state with the number of d-electrons $n_d \leq 5$, only two stable configurations, d^0 and d^5, of localized electrons are formed. Using X-ray spectroscopic and Hall coefficient data, the statistical weight of atoms having stable d^5-configurations (SWASC) in the metallic crystal has been determined.[14]

In the case of alkali and alkaline earth metals the

G. S. UPADHYAYA is Associate Professor, Department of Metallurgical Engineering, University of Roorkee, Roorkee (U.P.), India.

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