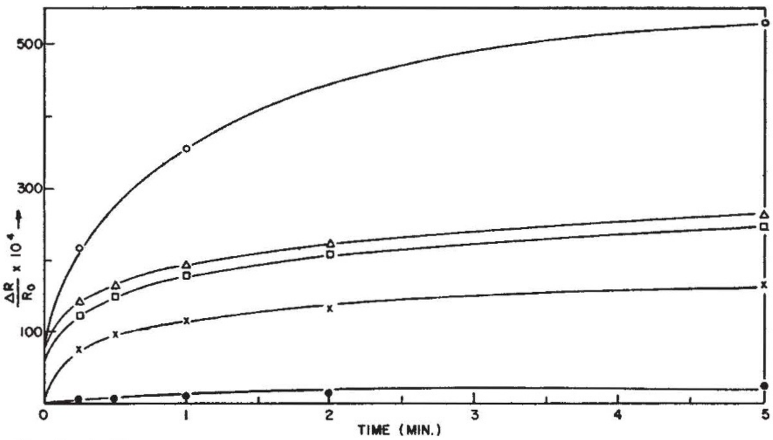

Fig. 1. Ageing curves at 30° C after quenching, reversion, and reversion and straining for various numbers of cycles (see text). ○, As quenched; ×, 10^2 cycles; □, 10^3 cycles; △, 10^4 cycles; ●, as reverted

re-aged at 30° C, and the electrical resistance determined in liquid nitrogen by means of an interruption technique.

The results for strain cycles of 0, 100, 1,000 and 10,000 are shown in Fig. 1. The maximum strain amplitude was ±0·0020 in./in. Data for the isothermal ageing of cyclically strained specimens are clearly representative of accelerated rates of zone formation—the rate increases with the number of cycles. It should be noted that the resistivity always initially increases during the formation of Guinier–Preston zones in this system[2].

We conclude that vacancies must be generated by cyclic straining of the reverted alloy and that these defects are able to contribute to diffusive processes, thus significantly aiding the transport of solute atoms to zones. An estimate of the excess vacancies (C_v) generated by cyclic straining can be obtained by applying the empirical relation of Seitz[4]: $C_v = 10^{-4}\varepsilon$, where ε is the total plastic strain. For 1,000 cycles, the atom fraction of vacancies thus obtained is of the order of 10^{-5}. This number is close to what would be expected for quenching from 500° C; however, it is certain that, before it is strained, the reverted alloy contains less than 10^{-8} atom fraction of vacancies[3].

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[1] Derrick Jones, W. J., and Dover, W. D., *Nature*, **209**, 704 (1966).
[2] Kelly, A., and Nicholson, R. B., in *Prog. Materials Sci.*, **10** (Macmillan and Co., 1963).
[3] Roberge, R., and Herman, H. (to be published).
[4] Seitz, F., *Adv. in Phys.*, **1**, 43 (1952).

Room Temperature Stress Corrosion Cracking of Titanium Alloys

IT has been known for more than 10 years that titanium alloys suffer from intergranular stress corrosion cracking if they are in contact with chlorides at elevated temperatures (> 250° C), but it was only 18 months ago that Brown[1] discovered that stress corrosion failures could occur at room temperature in a 3 per cent solution of sodium chloride. Titanium alloys are highly resistant to pitting attack in chloride solutions, and in order to investigate crack propagation rather than crack initiation, Brown used specimens of titanium alloy in the form of notched rectangular bars which had been fatigued in air until fine cracks had formed at the base of the notch. He found with static load tests that under plain strain conditions a 3 per cent solution of sodium chloride caused a decrease in the resistance of the alloy to the further propagation of the crack. This was a very important result, as it indicated that the stress corrosion resistance of titanium alloys under marine conditions depended on the resistance of the surface oxide on the alloy to the solution and not on the intrinsic resistance of the alloy lattice to the propagation of a stress corrosion crack which is the only really safe criterion.

The situation is far more serious than suggested by the experiments of Brown, as we have recently found that stress corrosion cracking of a single phase α-titanium alloy (Ti-5Al-2·5 Sn) in 3 per cent solutions of sodium chloride does not require fine surface notches or fatigue cracks, and it can occur readily on flat chemically polished sheet specimens at room temperature.

By examining thin foils of the alloy by transmission electron microscopy, we had previously shown[2] that hydrides were formed in the alloy surface when the alloy was plastically deformed while immersed in a 3 per cent solution of sodium chloride. This occurred only in susceptible alloys and only in the specific cracking environment, and on the basis of these observations and other data we believe that hydride formation is part of the cracking mechanism. We had also found that at some stage during the chemical polishing of susceptible titanium alloys in a mixture of 40 per cent hydrogen fluoride and 72 per cent nitric acid in the volumetric ratio 2 : 3 the alloy surface became contaminated with hydrides. We therefore tested chemically polished Ti-5Al-2·5 Sn alloy by bending sheet specimens into a curved shape while immersed in a 3 per cent solution of sodium chloride acidified with hydrochloric acid to pH 0·75 and then clamping them. Within 6 weeks the specimens developed transgranular cracks on the outer surface of the bend. Specimens that were not chemically polished still show no signs of cracking even after exposure for 3 months.

We shall report on the mechanism of cracking and the crystallographic features of hydride precipitation on a later occasion. The purpose of this communication is to report that pre-existing notches are not required for stress corrosion cracking to occur in titanium alloys, and also to direct attention to the importance of surface preparation in determining susceptibility. The implications of these two points are important both in the determination of the cracking mechanism and in the future use of titanium alloys in marine engineering.

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[1] Brown, B. F., and Beachem, C. D., *Corr. Sci.*, **5**, 745 (1965).
[2] Sanderson, G., and Scully, J. C., *Corr. Sci.* (to be published).

CHEMISTRY

Pseudorutile—a New Mineral Intermediate between Ilmenite and Rutile in the N Alteration of Ilmenite

ALTERATION of the mineral ilmenite, $FeO{\cdot}TiO_2$ in nature involves the processes of oxidation and leaching whereby iron is progressively removed to give a residual product, essentially TiO_2. Several investigations have been reported of the alteration products of ilmenite, but apart from composites of known oxides of iron and titan-