Measurements of heat flux[5] have indicated[1] that the complete transition from forced to free convection may take place much more sharply than had previously been supposed. This is thought to be a manifestation of the tendency of the temperature profile to adjust itself to the heat flux, and in particular to adopt a form which permits a constancy of heat flux with height. From the dynamics of the columnar and planar forms of convection, it can be shown that, assuming the profile to be of the form

$$\frac{\partial\theta}{\partial z} \propto z^{-\delta}$$

the constancy of heat flux is satisfied when $\delta = 1$ and forced convection dominates, and when $\delta = 4/3$ and free convection dominates, but not in the intermediate state when both mechanisms are operative. Close to the ground will be a layer where forced convection is dominant, provided some wind is blowing. But above the level at which the effects of free convection first begin to be felt, there will be a strong adjustment bias towards the 4/3 power law which allows free convection to dominate. Under ideal conditions of test, that is, when lag and advective effects are negligible, the intermediate state should occupy only a rather narrow range of levels (under given conditions) or of conditions (at a given level) and would tend to be transient. A fuller account of this work is in preparation.

C. H. B. Priestley

Division of Meteorological Physics,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
Sept. 22.

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Metallographic Evidence of Mechanical Twinning in an Alpha–Beta Titanium Alloy

As part of an investigation of the response of titanium alloys to heat treatment, longitudinal metallographic sections were prepared through the fracture region of broken tensile specimens. Metallographic examination of the tensile fractures of commercial titanium–aluminium–manganese (92–4–4) alloy (*C*-130*AM*), heat-treated to produce acicular alpha in a beta matrix, has resulted in the discovery of structures tentatively identified as mechanical twins.

An example of the appearance of the twinned structure is shown in Fig. 1. The twinned orientation is confined to the close-packed hexagonal alpha phase, but appears to pass unhindered through the intervening body-centred cubic beta phase, so that each twin can be followed across several adjacent alpha needles. No evidence of twinning is visible in the beta phase, indicating that the twinning distortion is carried through the beta phase by a slip process.

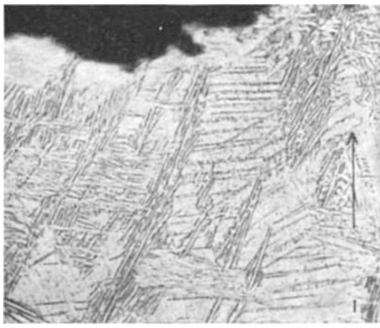

Fig. 1. Mechanical twinning near the fracture in tensile specimen of *RC*-130*B* titanium alloy. × 250

Fig. 2. Steplike twin structure near fracture in tensile specimen of *RC*-130*B* titanium alloy. × 250. Arrows show direction of tensile stress

Another example of twinning in this alloy is shown in Fig. 2. A large movement of the alpha needles is evident, forming a pronounced steplike structure. It is improbable that this amount of distortion could be developed during polishing. Therefore it is concluded that twinning occurs normally during the deformation process.

Twins thus far observed have tended to be quite broad and to be lens-shaped in appearance. This appearance has been shown by Rosi *et al.*[1] to be typical of $\{10\bar{1}2\}$ type twins in alpha-titanium.

The two structures shown were obtained during examination of standard 1-in. gauge-length round tensile specimens broken with a platen speed of 0·01 in. per min. Total elongation before fracture was approximately 8 per cent. These specimens had been heat-treated to produce a fine acicular alpha structure in a continuous beta matrix by heating into the all-beta field and cooling at a rate sufficiently slow to promote the nucleation and growth of the acicular alpha structure. With this heat treatment, the coarseness of the alpha needles can be controlled to a considerable extent by controlling the rate of cooling through the beta-to-alpha transformation.

Twinning has also been observed in specimens heat-treated to produce considerably coarser alpha needles; but, in these cases, the extent of twinning was much less. Twinning was generally most prominent in the region of fracture; but occasional isolated regions showing twinning have been observed at considerable distances from the fracture.

If X-ray examination confirms these structures to be true mechanical twins, the observation that twinning can be propagated across intervening non-twinning material without loss of continuity of the twin boundary should prove of assistance in developing a suitable theory of the twinning process.

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D. N. Williams

Nonferrous Physical Metallurgy Division,
Battelle Memorial Institute,
Columbus, Ohio.
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