crystals grown from the impure salt were bounded by the basal planes, {10$\bar{1}$1} planes and prismatic planes—such as {30$\bar{3}$1}, {30$\bar{3}$2}, etc. Crystals grew in thin plates when they were deposited from the molten salt at temperatures of 750°–850° C and at low current densities (less than 100 amp/dm^2); in such cases their directions of growth were parallel to the basal plane. However, crystals grew in needles when they were deposited from the molten salt at temperature below 750° C with current densities greater than 150 amp/dm^2; under such conditions their directions of growth were parallel to <1$\bar{1}$01>, <1$\bar{1}$22> or <1$\bar{1}$03>.

Growth twins were frequently observed, their twinning planes being {10$\bar{1}$1}, {10$\bar{1}$2}, and {11$\bar{2}$1}. It is unusual to observe the {10$\bar{1}$1} plane as a twinning plane in the case of growth twin, and so far as we know such a situation has not been previously reported for deformation twins[3,5].

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1 Opie, W. R., *Trans. Amer. Inst. Min. Met., J. Metals*, 8, 1192 (1956).
2 Tomonari, Tadao, *Titanium*, 5, No. 11, 11 (1957).
3 Lin, T. S., and Steinberg, M. A., *J. Metals*, 4, 1043 (1952).
4 Straumanis, M. E., and Eppelsheimer, D. S., *Z. Krist.*, 111, 342 (1959).
5 Rosi, F. D., Dube, C. A., and Alexander, B. H., *J. Metals*, 5, 257 (1953).

Liquid Metal Heat Transfer in Packed Beds

INVESTIGATIONS of heat transfer in liquid metal irrigated packed beds counter current to gases do not appear to have been, so far, reported in the literature. Yet, the problem is of unquestionable interest in extractive metallurgy, as was shown by Shu-p'ei[1] in his discussions on the iron blast furnace.

The apparent absence of liquid metal heat transfer investigations in packed beds may perhaps be explained by the experimental difficulties of preventing the occurrence of simultaneous mass transfer effects and/or separating the two phenomena analytically from the combined results. It is, however, suggested that useful insight into the foregoing phenomenon could be obtained with ambient, or slightly elevated temperature systems in which the Dufour effect could be justifiably considered unimportant. Mass transfer studies by Warner[2] concerning the absorption of zinc vapour in molten lead flowing through a bed packed with steel Raschig rings have shown the usefulness of this type of investigation. The extension of his work to heat transfer studies in similar systems appeared logical. To this end, in co-operation with Dr. N. A. Warner at the University of New South Wales, I have carried out some heat transfer experiments in beds of different packings irrigated with mercury counter current to various gases. Although many difficulties had to be overcome and some problems still remain to be solved, the results of the studies indicate, *inter alia*, that the transfer is predominantly gas phase controlled and the data could be correlated, with some degree of accuracy, by a Nusselt type expression. The actual correlation featured a liquid hold-up term in addition to the usual moduli which, except for Prandtl number, were modified to account for the unknown heat transfer area involved.

Investigations are at present in progress using a fusible alloy to study the various unsolved problems of heat transfer investigations with mercury. These include the elucidation of the part played by the packing in the heat transfer mechanism and by the various parts of the liquid hold-up, and, the evaluation of the exponent of $Cp\mu/k$, which in the investigations with mercury was assumed to be equal to 0·33.

One of the findings of the work on mercury that is unlikely to be altered appreciably by future results is the apparent heat transfer efficiency of these systems when compared with tubular exchangers or certain fluidized beds and spray columns.

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1 Shu-p'ei, Yu, *Contemporary Problems of Metallurgy*, edit. by Samarin, A. M. (U.S.S.R. Acad. Sci., Moscow, 1958).
2 Warner, N. A., *Chem. Eng. Sci.*, 11, 161 (1959).

Twinning at 77° K of 'Flash-annealed' Niobium

NIOBIUM is known to twin at 77° K, and for the purest reported[1] the estimated lower yield stress was ~40 kg mm^{-2} and the maximum tensile stress only a little higher. For specimens of this purity the lower yield stress at room temperature was ~7 kg mm^{-2}.

At about this strain rate the yield stress of niobium free of impurities is predicted[2] to be ~2·5 kg mm^{-2} and this is postulated to be the Peierls–Nabarro force. Considering this model, the yield stress of this 'pure' niobium at 77° K should be ~50 kg mm^{-2}.

Using a 'flash-annealing' technique the proportional limit of niobium foils strained at 1 per cent min^{-1} was lowered to ~3·5 kg mm^{-2}. This material was strained at 77° K (liquid nitrogen bath) and one or more of the following phenomena was found to occur for specimens taken from the same foil. Proportional limit was some-

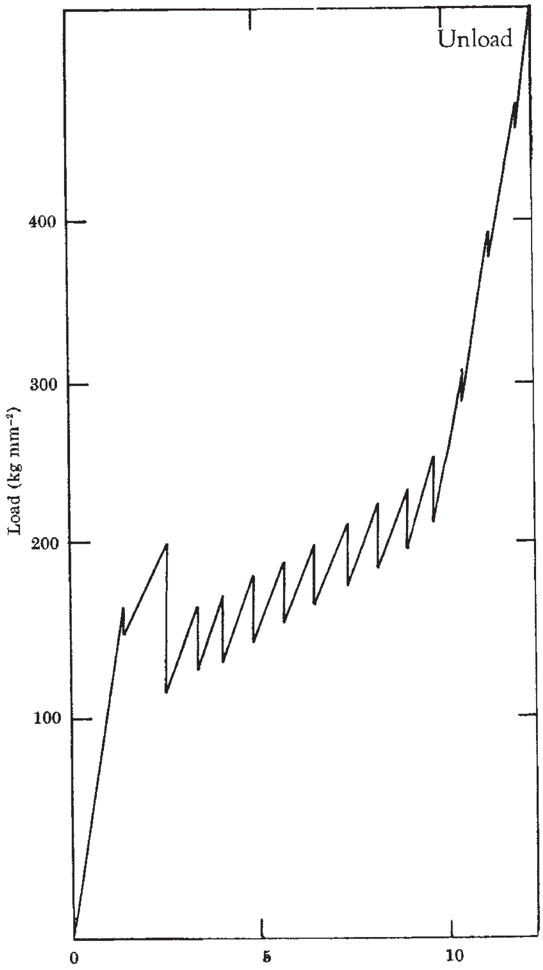

Fig. 1. A load-elongation curve at 77° K of 'flash-annealed' niobium