

Turnbull and Cormia (1960) suggested that the low measured activation energy for the formation of G.P. zones can be accounted for by vacancy traps at the zones. If vacancy traps are also present at θ'' and θ' precipitates of depth about 0.67 eV (assuming an activation energy of migration of 0.52 eV) to account for the low measured activation energy (1.19 eV) compared with the reported activation energy of copper in aluminium (1.4 eV), then the traps are of the same type at the θ'' and θ' precipitates. It is considered extremely unlikely that the low activation energy can be explained by either grain boundary diffusion or diffusion along dislocations in the present work.

2. It has been mentioned that Beyeler and Adda (1968) obtained an uncorrected value of $12.5 \text{ cm}^3 \text{ mole}^{-1}$ for the activation volume for self-diffusion in aluminium and this value is within the experimental errors for the values obtained for θ'' and θ' formation. A direct comparison of the activation volumes for θ'' and θ' formation and that for self-diffusion in aluminium cannot be made because present theories (Le Claire 1962 and Corless and March 1961) have considered very dilute alloys which Al-4% Cu certainly is not. However, the magnitude of the measured activation volumes and the fact that they are the same for both types of precipitate show that pressure is inhibiting the diffusion of copper to the precipitates and not inhibiting the nucleation of the precipitates.

3. The magnitude of the measured activation volumes shows that the vacancy concentration is at thermal equilibrium or not greatly in excess of it. This would lend some credence to the same sort of suggestion to that which has been put forward by Stoebe and Dawson (1968) for self-diffusion in aluminium, that the migration energy component of the activation energy for the diffusion of copper in aluminium is, for some reason, temperature dependent and the activation energy is, in fact, about 1.2 eV at 200°C. Then there would be no need to postulate vacancy traps at the precipitates. Obviously further diffusion work on copper in aluminium at various temperature ranges would have to be done to resolve this point.

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REFERENCES

- BEYELER, M., and ADDA, Y., 1968, *J. Phys., Paris*, **29**, 345.
BUTUZOV, V. P., 1957, *Soviet Phys. Crystallogr.*, **2**, 533.
CORLESS, G. K., and MARCH, N. H., 1961, *Phil. Mag.*, **6**, 1285.
CURTIN, H. R., DECKER, D. L., and VANFLEET, H. B., 1965, *Phys. Rev. A*, **139**, 1552.
DE SORBO, W., TREAFITIS, H. N., and TURNBULL, D., 1958, *Acta metall.*, **6**, 401.

- GOLIBER, E. W., MCKEE, K. H., KASPER, J. S., TILLYARD, J. E., CAHN, J. W., and PHILLIPS, V. A., 1959, General Electric Research Report, No. WADC-TR-59-747.
- HALL, T., 1958, *Rev. scient. Instrum.*, **29**, 267.
- HANNEMAN, R. E., and STRONG, H. M., 1965, *J. appl. Phys.*, **36**, 523; 1966, *Ibid.*, **37**, 612.
- HARVEY, J. S., KAUFMAN, L., KULIN, S. A., LEYENAAR, A., and UDIN, H., 1960, Wright Air Development Center Technical Report, No. 59-655.
- HILLIARD, J. E., and CAHN, J. W., 1961, *Progress in Very High Pressure Research*, edited by F. P. Bundy, W. R. Hibbard, and H. M. Strong, (John Wiley), p. 109.
- KING, J. H., 1965, *J. scient. Instrum.*, **42**, 374.
- LE CLAIRE, A. D., 1962, *Phil. Mag.*, **7**, 141.
- LLOYD, E. C., HUTTON, U. O., and JOHNSON, D. P., 1959, *J. Res. natn. Bur. Stand. C*, **63**, 59.
- NICHOLSON, R. B., THOMAS, G., and NUTTING, J., 1958, *Br. J. appl. Phys.*, **9**, 25.
- PHILLIPS, V. A., 1961, *Acta metall.*, **9**, 216.
- STOEBE, T. G., and DAWSON, H. I., 1968, *Phys. Rev.*, **166**, 621.
- TURNBULL, D., and CORMIA, R. L., 1960, *Acta metall.*, **8**, 747.
- WEATHERBURN, C. E., 1961, *A First Course in Mathematical Statistics* (Cambridge University Press).
- WERT, C. A., and THOMPSON, R. M., 1964, *Physics of Solids* (McGraw-Hill), p. 54.