cesium into a rapidly purified sample of barium followed that to be expected for the growth of a positron emitter into a parent which contained too small a quantity of particulate radiation to be detected with the end-window counter employed in the experiment. From these two facts it appears that Ba^{128} must decay principally by electron capture, since the equilibrium mixture of isobars contained the positrons reported by Fink and Templeton.[1] K-x-radiation was also found to be associated with the 3.8-minute cesium daughter as determined on a single-channel scintillation pulse analyzer. If these x-rays be due to electron capture rather than conversion of gamma-radiation, it would appear that 25 percent of the Cs^{128} decayed through electron capture. A barium sample was investigated for gamma-radiation on the pulse analyzer, but interference because of Compton recoils from the annihilation radiation rendered results inconclusive.

A barium isotope of 12-minute half-life was found whose radiations were not directly characterized. However, positron emission is probable since electromagnetic radiation seemed to comprise no more than five percent of the total activity detectable on an end-window counter. By four rapid chemical separations made at ten-minute intervals a cesium activity was obtained from the barium whose half-life and radiation characteristics agree with those reported for Cs^{127}.[3] Furthermore, the yield of this nuclide diminished roughly by a factor of two in each of the four successive separations. The 12-minute barium activity is thus Ba^{127}.

1 R. W. Fink and D. H. Templeton, J. Am. Chem. Soc. **72**, 2818 (1950).
2 R. W. Fink and E. O. Wiig, J. Am. Chem. Soc. **73**, 2365 (1951).
3 Fink, Reynolds, and Templeton, Phys. Rev. **77**, 614 (1950).

The Cottrell-Bilby Theory of Yielding of Iron

TAKEO YOKOBORI
Institute of Science and Technology, University of Tokyo, Komaba-machi, Meguro-ku, Tokyo, Japan
(Received September 29, 1952)

ALTHOUGH the mechanism of yielding of iron by Cottrell and Bilby[1] (C-B theory) is the best one that has been proposed, there seem to be ambiguities concerning the method of deriving the equation of temperature and strain rate dependence. It may be much more reasonable to derive it from the following equation:

$$dm/dt = m^2, \tag{1}$$

in which m denotes the transition probability. Equation (1) was previously developed by the author,[2] considering the yield phenomenon as a Markoff process. In the C-B theory, m refers to the probability that a dislocation is released from the carbon atmosphere by an external stress, and it is given by

$$m = B\exp[-U(\sigma/\sigma_0)/kT]. \tag{2}$$

Hence, substituting the value of m from Eq. (2) into Eq. (1), we find

$$\log(v/BkT) + \log(-\partial U/\partial\sigma) = -U/kT, \tag{3}$$

in which $v = d\sigma/dt$ = stress velocity. The change of T involved in $\log(1/T)$ may be neglected compared with that involved in U/kT. Only when the term $\log(-\partial U/\partial\sigma)$ is negligible, does Eq. (3) become

$$BkT = v\exp(U/kT), \tag{4}$$

which is the same formula as in the C-B theory.[1]

Corresponding to each four series of U–σ/σ_0 curves in the C-B paper,[1] the curves of $U/\alpha(2AW\rho)^{\frac{1}{2}}$ *versus* σ/σ_0 were drawn as solid lines (as shown in Fig. 1), which approximate the curves in the C-B paper. In Fig. 1 the α's are suitably chosen constants, which are different for each four series, respectively; and $\alpha(2AW\rho)^{\frac{1}{2}}$ has such a unit that the ordinates become dimensionless. It is found that these curves are approximately equivalent to the curve of $-\log(\sigma/\sigma_0)$, as shown by the dashed line in Fig. 1. That is,

$$U \doteqdot -(1/n)\log(\sigma/\sigma_0), \tag{5}$$

where $1/n = \alpha(2A\overline{W}\rho)^{\frac{1}{2}}$. Substituting $U = -(1/n)\log(\sigma/\sigma_0)$ in Eq. (3) gives

$$\log(v/nBkT\sigma_0) = (1/nkT+1)\log(\sigma/\sigma_0). \tag{6}$$

Since $1/nkT$ was found to be much larger than unity in the cases corresponding to these four series of U–σ/σ_0 curves, Eq. (6) becomes

$$nkT\log(v/nBkT\sigma_0) = \log(\sigma/\sigma_0). \tag{7}$$

Thus, the logarithm of yield stress should be proportional to the absolute temperature. The experimental results[3] are in good agreement with Eq. (7), as shown in Fig. 2.

It is interesting that from Eq. (7) the dependence of yield stress on strain rate $\dot{\epsilon}$ is given by the power law:

$$\sigma \propto \dot{\epsilon}^{nkT}. \tag{8}$$

If one uses the parameters corresponding to the No. 2 curve in the C-B paper,[1] then the exponent at room temperature is

$$nkT = 0.022,$$

which is in good agreement with the value 0.020 obtained in Deutler's experiments[4] upon mild steel.

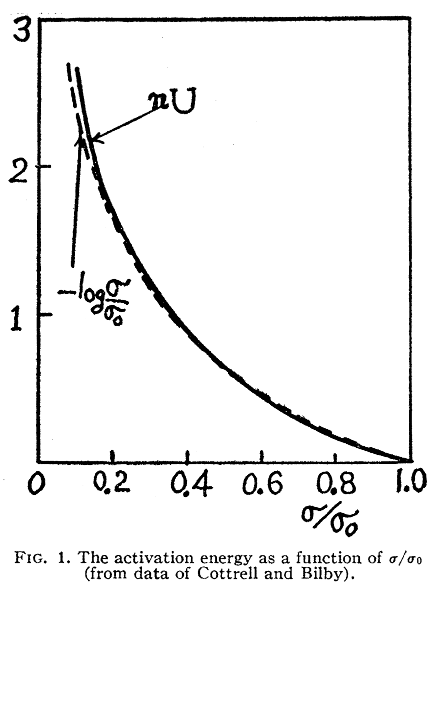

FIG. 1. The activation energy as a function of σ/σ_0 (from data of Cottrell and Bilby).

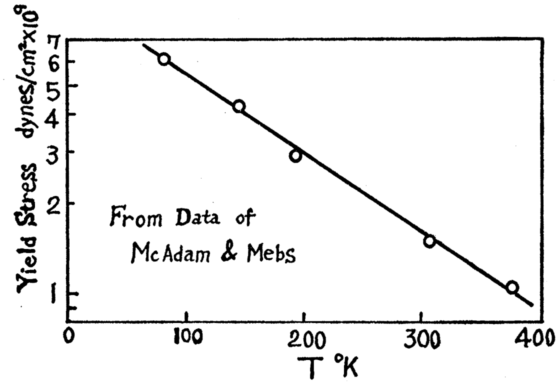

FIG. 2. The dependence of yield stress on temperature (from data of McAdam and Mebs).

1 A. H. Cottrell and B. A. Bilby, Proc. Phys. Soc. (London) **62A**, 49 (1949).
2 T. Yokobori, J. Phys. Soc. Japan **7**, 44 (1952).
3 D. J. McAdam, Jr. and R. W. Mebs, Proc. Am. Soc. Testing Materials **43**, 661 (1943).
4 C. Zener and J. H. Hollomon, J. Appl. Phys. **15**, 22 (1944).