

by the partially oxidised rod. From the slope of the straight line so obtained the surface area per unit mass may be calculated.

Let M be the mass of the nickel being oxidised, and S be its surface area,
 c be the initial conductivity of the metal,
 t be the thickness of the oxide film when the initial conductivity has fallen by Δc , and
 μ be the refractive index of the oxide for middle of the absorption or reflection band in the spectrum of the film.

Then

$$\frac{S}{M} = \frac{74.7}{6.4 \times 58.7} \cdot \frac{\mu \cdot \Delta c}{c \cdot t}$$

For the electrolytic metal the preliminary results gave 3.94×10^3 sq. cm. per gram; on activation by alternate oxidation and reduction at 520°C ., the value fell to 3.10×10^3 ; this catalyst was oxidised and reduced at 400°C . On re-oxidation at 400°C . the active portion of the surface, which oxidised very easily, had the increased area of 1.4×10^4 sq. cm. per gram. The area of the supporting material was 2.14×10^3 sq. cm. per gram of nickel, showing that the surface of electrolytic nickel is 1.84 times the apparent area, and that the apparent surface may be increased considerably by reduction at 400°C .

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Thermal Degeneration of the X-ray Haloes in Liquids.

THE theory of X-ray diffraction in fluids put forward some years ago by the writer with Dr. Ramanathan (*Proc. Ind. Assoc. Cult. of Science*, vol. 8, pp. 127-162; 1923) indicates that the diffraction halo exhibited by liquids under ordinary conditions should be strikingly modified by rise of temperature. As explained in that paper, it follows from thermodynamic considerations that at ordinary temperatures the molecules of a liquid are ordered in space with a high degree of regularity, and the comparative sharpness of the X-ray halo at such temperatures is a consequence of this fact. With rise of temperature, however, the molecules are thrown into increasing disorder, as is shown by the considerably enhanced scattering power of the liquid for ordinary light. Accordingly, we should expect the X-ray halo to become more diffuse and faint; it should also contract to some extent, owing to the diminished density and consequent increase of the mean distance between neighbouring molecules. Vice versa, if the liquid is supercooled until it congeals into a glassy solid, we should expect the halo to become sharper and brighter, and at the same time to dilate somewhat.

These consequences of the theory as well as the influence of the asymmetrical shape of the molecules on the structure of the X-ray haloes, were set out clearly in the paper, though at the time it was written no experimental evidence could be adduced in support. It is satisfactory to note that an examination of the subject undertaken by Dr. N. K. Sethi and Mr. S. S. Ramasubramanian in the writer's laboratory has shown the predicted degeneration of the diffraction halo with the rise of temperature to be an experimental fact. There is found, as expected, a progressive change of the halo from a comparatively sharp and bright ring in the amorphous solid at low temperatures to a fainter and more diffuse aureole in the liquid state at high temperatures.

210 Bow Bazar Street,
Calcutta, Oct. 16.

C. V. RAMAN.

Solution of the Equation $\sin \theta/\theta = c$.

A MUCH simpler solution of the above equation than that given by Mr. V. Naylor in *NATURE* of Oct. 1 may be derived by expanding the expression on the left into a series of ascending powers of θ , and transferring the higher terms by successive approximations to the other side as terms in powers of d , where $d = 1 - c$. The solution so obtained is:

$$\theta = \sqrt{6(d + 0.3d^2 + 0.137d^3 + \dots)}$$

This expression is so convergent that the second term does not affect the value of θ by half a second for values of θ up to $2^\circ.6$, the third up to 15° , and higher terms only affect the result for angles more than 30° . For small angles, or for a fair approximation with larger angles, we may simply write the solution $\theta = \sqrt{6d}$, or for θ in degrees, $140^\circ.345 \sqrt{d}$. If c be very near unity, the complement has fewer significant figures than the reciprocal, while the terms in d^2 and d^3 , when required, are so small that they can be worked by slide rule or three- or four-figure logarithms for adding to d .

A. E. LEVIN.

1 Denbridge Road,
Bickley, Kent, Oct. 8.

Viscosity of Metals: Bismuth.

SINCE publishing the concluding part of my investigations on the viscosities of metals (*Phil. Mag.*, April 1927, Supp.) I have come across the following data for bismuth—a metal I could not procure in the form of a wire. In an attempt to study, for a different purpose, the elastic properties of pure bismuth wires prepared from electrolytically deposited metal, J. E. Harris (*Phys. Rev.*, First Series, 35, pp. 95-119) tabulated the values of log. dec. for different amplitudes for a wire of length 106 cm.; diam., 0.25 mm.; period, 10.498 sec.; moment of inertia of the solid, 133 gm. cm.²; which on extrapolating for zero amplitude give $\lambda_0 = 0.00978$. These results give for the coefficient of viscosity of bismuth, at $23^\circ.7 \text{C}$., 13.71×10^8 poises—a value quite in a line with others obtained by me with thirteen metals and seven alloys.

As these experiments were not conducted in an air-free chamber the above result for bismuth is, however, likely to be slightly higher.

G. SUBRAHMANYAM,
Vizianagaram,
S. India, Sept. 1.

The Temperature Variation of the Elasticity of Rochelle Salt.

MR. R. MORGAN DAVIES's letter on this subject in *NATURE* of Sept. 3, recalls at once the analogy between piezo-electric phenomena and the reciprocal relations between strain and magnetic properties shown by ferromagnetic metals.

In particular, there is a stationary value in the Young's modulus—temperature curve for nickel at about 400°C ., the Curie point for that material (*Proc. Phys. Soc.*, London, vol. 27, Dec. 15, 1914).

A close examination of the temperature variation of the thermal expansion of a piezo-electric crystal would be expected to reveal a discontinuity at the temperature of abrupt change in the piezo-electric modulus which, if present, would be analogous to that found by the writer in the thermal expansion of nickel (*Phil. Mag.*, June 1904), and confirmed by Colby (*Phys. Rev.*, 30, pp. 506-521; April 1910).

E. P. HARRISON.

H.M.S. Vernon,
Portsmouth, Oct. 19.