FIG. 5. The effect of hexene-2 in *n*-hexane on conduction current with and without irradiation.

the integration of Eq. (2) gives

$$1/q = 1/q_0 + kt, \quad (3)$$

where q_0 is the space-charge density at steady state, that is, just after short circuit. The potential created by the space charges can be considered to be approximately proportional to q according to Poisson's equation. Thus

$$\int_{x_0}^0 E(x,t) dx = \int_{x_0}^{d/2} E(x,t) dx = cq. \quad (4)$$

Therefore, Eq. (1) can be approximately reduced to

$$I \approx (2A/d)(n_1 - n_2) \mu e c q \approx bq, \quad (5)$$

where b and c are constants. Substitution of Eq. (3) into Eq. (5) gives

$$1/I = 1/bq_0 + kt/b. \quad (6)$$

The plot of $1/I$ vs t after short circuit for various charging voltages gives straight lines, as shown in Fig. 4, indicating the good agreement between the experimental results and theory.

Some experiments have also been performed with mixed liquids and the results are given in Fig. 5. The conduction current in non-irradiated *n*-hexane is significantly increased by the addition of a small percentage of hexene-2. This may be mainly due to a higher concentration of impurities in hexene-2 than in *n*-hexane. But under irradiation the steady-state induced current decreases with increase of hexene-2 concentration, reaching a minimum with an addition of about 0.4% and rising as the percentage is increased. Since the hexene-2 has a double bond which tends to capture negative oxygen ions, the negative ions then become less mobile, thus decreasing the induced current with the addition of a small amount of hexene-2. This phenomenon confirms the suggestion by Allen and Hummel.⁵ If the concentration of hexene-2 is increased, the other impurities more actively contribute to conduction causing an increase in induced current.

It should be mentioned that the experimental results are not affected by the polarity of the applied voltages, and the induced currents being reported are the measured current under irradiation, which may be different from the actual induced current by a component due to the ionic impurities originally in the liquid.

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Orientation Dependence of a Dislocation Etch for Zinc**

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THE dislocation etch for (10 $\bar{1}0$) surfaces of zinc reported by Brandt, Adams, and Vreeland^{1,2} has been further explored. Additional surface orientations have been found where dislocation etching takes place. These orientations cover an area located between 3° and 12.2° to the [0001], and the area is symmetric about that axis. Attempts to produce dislocation etching on

FIG. 1. Surfaces on which good, marginal, and poor etching is observed.

0.01 in.

(0001) TRACE
{1212} TRACES

FIG. 2. A scratched and etched surface whose normal is 10° from [0001] and 80° from [1210].

FIG. 3. Slip bands on the $\{1\bar{2}1\bar{2}\}\{1\bar{2}1\bar{3}\}$ system of zinc which formed during a stress pulse, 425 psi (resolved), 17-msec duration, as revealed by etching. The $[1\bar{2}10]$ compression axis is vertical. (a) $(10\bar{1}0)$ surface. (b) $(101\ 24)$ surface.

surfaces within 2° of (0001) were generally unsuccessful. This is in contrast with the etching of many crystals which takes place only within a few degrees of a low index plane.

The crystallographic surfaces on which good and marginal dislocation etching is observed are shown on a segment of a sphere in Fig. 1. Good etching of surfaces near $(10\bar{1}0)$ extends 25° from the $[10\bar{1}0]$ toward $[0001]$, and 5° toward $[01\bar{1}0]$.

The appearance of an etched surface whose normal is 10° from the $[0001]$ and 80° from the $[1\bar{2}10]$ is shown in Fig. 2. The surface was intentionally damaged with two razor blade scratches. The trace of (0001) planes on the surface is indicated, and dislocations are revealed lined up in the general direction of the $\{1\bar{2}1\bar{2}\}$ second-order pyramidal slip-plane traces (indicated by the dashed lines). The dark lines emanating from the scratches are twins.

Etched $(10\bar{1}0)$ and $(101\ 24)$ surfaces of a crystal which has been pulse-loaded in $[1\bar{2}10]$ compression are shown in Fig. 3. The $(101\ 24)$ surface is about 5° from (0001) . Dislocations in the $\{1\bar{2}1\bar{2}\}\{1\bar{2}1\bar{3}\}$ slip bands formed by the pulse load, which intersect the $(10\bar{1}0)$ surface, are predominantly of edge orientation while those intersecting $(101\ 24)$ are predominantly of screw orientation.

We conclude that dislocations of the $\{1\bar{2}1\bar{2}\}\{1\bar{2}1\bar{3}\}$ slip system are revealed on etched surfaces near (0001) as well as on surfaces near $\{10\bar{1}0\}$. It has been demonstrated² that both edge and screw oriented dislocations on the basal $(0001)\{1\bar{2}1\bar{0}\}$ slip system are revealed on surfaces near $\{10\bar{1}0\}$. The failure of the etch to reveal dislocations on surfaces within 2° of (0001) is not understood.

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Electrical Conductivity Measurements for Good Insulators

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SEVERAL authors¹⁻³ carried out measurements of the electrical conductivity of semiconductors and photoconductors with a method consisting of measuring the mechanical torque T generated by a rotating field $E(t)$ on a sample suspended with a wire.

Ogawa³ proposed a theory in which the torque generated in the sample (a crystal) along z axis is given by

$$T_z = \frac{1}{2} V E^2 \left\{ \frac{\sigma_x / \omega}{[1 + L_x(\epsilon_x - \epsilon_0)]^2 + (\sigma_x L_x / \omega)^2} + \frac{\sigma_y / \omega}{[1 + L_y(\epsilon_y - \epsilon_0)]^2 + (\sigma_y L_y / \omega)^2} \right\}, \quad (1)$$

where V is the volume of the sample; $\omega/2\pi$ is the frequency; ϵ_x , ϵ_y are the dielectric constants; E is the electric field; L_x , L_y are the depolarization factors; and σ_x , σ_y the electrical conductivities.

If the sample is electrically isotropic (such as Teflon, Plexiglas, etc.), Eq. (1) becomes

$$T = V E^2 \left\{ \frac{\sigma / \omega}{[1 + L(\epsilon - \epsilon_0)]^2 + (\sigma L / \omega)^2} \right\}. \quad (2)$$

If the sample is electrically anisotropic and one sample dimension dominates the others, $L_x \gg L_y$, some simplifications may be made in the expression of T_z .

$$T_z = \frac{1}{2} V E^2 \left\{ \frac{\sigma_x / \omega}{[1 + L_x(\epsilon_x - \epsilon_0)]^2 + (\sigma_x L_x / \omega)^2} \right\}. \quad (3)$$

We have a maximum of this expression for

$$\omega_{\max} = L_x \sigma_x / [1 + L_x(\epsilon_x - \epsilon_0)],$$

and we can see that, for frequencies far from $\omega_{\max}$, $L_x(\epsilon_x - \epsilon_0) \ll 1$, the expression of torque (3) becomes

$$T = \frac{1}{2} V E^2 (\sigma / \omega). \quad (4)$$

We can say the same thing for isotropic materials:

$$T = V E^2 (\sigma / \omega). \quad (5)$$

The apparent sensitivity of measurements is 10^{-16}

It is possible to show that the Lampa's formula,⁴ relating the torque generated by an electric rotating field in an ampule full of liquid, is nothing other than a particular case of the theory developed by Ogawa; in fact $L_x = L_y = \frac{2}{3} \epsilon_0$, $\sigma_x = \sigma_y$, $\epsilon_x = \epsilon_y$, and

$$T = K E^2 \{ \sigma \omega / [\omega^2 (2 + \epsilon)^2 + h \sigma^2] \}. \quad (6)$$

The experiment was carried out with a monocrystal of sulfur and a cylinder of Teflon.

The apparatus consists of a box, in which there are two pairs of plates where the rotating electric field is applied, in which the sample is suspended with a Nichrome wire 1-m long and with a radius $r = 2 \times 10^{-6}$ m.