

amounts of cristobalite (namely, after 3-4 hr.), the strength diminished rapidly; expansion again occurred as the result of the continued conversion of quartz into forms of lower density.

Sintering and shrinkage of pure oxides at high temperatures are usually attributed to diffusion and the formation of 'necks' or lenses at points of contact between the particles. Examination of the quartz under the microscope showed that this mechanism was operative. Fig. 2 illustrates typical examples of the abundant neck-growth found after firing for  $2\frac{1}{2}$  hr., when about 20 per cent of the intermediate phase and virtually no cristobalite had developed. Fig. 2a is in ordinary light; Figs. 2b and 2c, in polarized light with partial and total extinction respectively, clearly indicate the intermediate phase as a continuous isotropic layer surrounding the residue of the quartz crystal and forming the neck between the particles. Sintering in quartz thus appears to take place via the disordered surface layer developed at high temperatures and is not inherent in the crystal. The rapid drop in strength on continued heating suggests that cristobalite is similarly deficient in sintering characteristics at the temperatures used. Full details of this work will be published shortly.

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<sup>1</sup> Gaskell, J. A., Grimshaw, R. W., and Roberts, A. L., 47th Report of the Joint Refractories Committee, 1955-56. Gas Council Publication, G.C.30.

## CHEMISTRY

### Ionization Potentials of Electron Donors

RECENTLY, Briegleb and Czekalla<sup>1</sup> have described a method of determining the ionization potentials ( $I_p$ ) of electron donors from the frequencies ( $\nu$ ) of the charge-transfer bands of the complexes of these donors with certain electron acceptors. This is based on a non-linear theoretical relationship between  $I_p$  and  $\nu$ .

Similar results may be obtained from an empirical linear relationship between  $I_p$  and  $\nu$ ; this is sufficient to correlate the experimental values of  $I_p$  and  $\nu$ . Such relationships have been determined for complexes of donors of reliably known ionization potential<sup>2</sup> (namely, benzene, toluene, *m*-xylene, mesitylene, naphthalene, 1-methylnaphthalene and aniline) with the electron acceptors chloranil (*C*), *p*-benzoquinone (*Q*) and 1,3,5-trinitrobenzene (*T*) respectively. These are:

$$I_p = 5.13 + 1.39 \times 10^{-4} \nu_C$$

$$I_p = 4.61 + 1.33 \times 10^{-4} \nu_Q$$

$$I_p = 4.25 + 1.39 \times 10^{-4} \nu_T$$

for solutions in carbon tetrachloride, where  $I_p$  is in electron volts,  $\nu$  in  $\text{cm}^{-1}$ , and the subscripts to  $\nu$  indicate the appropriate electron acceptor.

From measurements of frequencies of charge-transfer bands of complexes of these three acceptors with other donors in carbon tetrachloride, the ionization potentials may be evaluated. Examples are quoted in Table I.

Table 1

Donor	Ionization potential (eV.)				
	Calc. from $\nu_C$	Calc. from $\nu_Q$	Calc. from $\nu_T$	Mean	Ref. 1
Durene	8.0	8.2	8.3	8.2	8.4
Pentamethylbenzene	7.9	7.9	7.9	7.9	—
Hexamethylbenzene	7.8	7.8	7.8	7.8	7.9
Anthracene	7.4	7.4	7.4	7.4	7.4
<i>N,N</i> -Dimethylaniline	7.3	7.3	7.1	7.2	—
<i>N,N,N',N'</i> -Tetramethyl- <i>p-p'</i> -diaminodiphenylmethane	7.1	7.0	7.1	7.1	—
<i>N,N,N',N'</i> -Tetramethyl- <i>p</i> -phenylenediamine	6.7	6.7	6.7	6.7	—

For aromatic electron donor molecules, save those of very low ionization potential where it is improbable that such relationships are justified, this method may provide a simple means of estimating ionization potentials which may be difficult to determine by other methods, such as Rydberg series, photoionization and electron impact, because of practical details such as the low vapour pressure of some of these substances.

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<sup>1</sup> Briegleb, G., and Czekalla, J., *Z. Elektrochem.*, **63**, 6 (1959).

<sup>2</sup> Watanabe, K., *J. Chem. Phys.*, **26**, 542 (1957).

### Radioassay of Aqueous Solutions mixed with Solid Crystalline Fluors

I HAVE previously described a new approach to direct radioassay of aqueous solutions of weak beta-ray emitting isotopes in the liquid scintillation spectrometer<sup>1</sup>. The aqueous solution was intimately mixed with a mass of finely divided beads of clear plastic into which a fluor (diphenylstilbene) has been incorporated (Pilot B-Beads, Pilot Chemicals, Inc., Watertown, Mass.). We wish to report that a number of crystalline fluors, more efficient, less expensive and more generally available, can be substituted for the plastic and used in an analogous fashion despite their poorer light-transmitting qualities<sup>2</sup>. For example, in a slurry made up of 0.7 ml.  $\text{Na}_2^{14}\text{CO}_3$  and 0.5 gm. diphenyloxazole the carbon-14 was counted with 27 per cent efficiency. Instead of trying to hold the solid fluor in stable suspension, which can be done with the help of thickeners such as glycerol, it has proved more satisfactory to let the fluor settle to the bottom of the vial. Addition of a detergent is essential to ensure prompt and uniform wetting of the crystals. The performance of a fluor depends not only on its inherent fluorescence efficiency but also on the size and shape of the crystals, since the closeness of packing determines the mean free path of beta-particles through the solution before they encounter a fluor crystal. Best results thus far have been obtained using blue-violet fluorescence-grade anthracene crystals (Distillation Products Industries, Rochester, N.Y.). This highly purified material was three times as efficient as ordinary 'chemically pure' anthracene. The difference may in part reflect the presence of trace impurities in the latter, known to