

atin gels and even fruit jam. He also described many of his own experiments which used silica gel. Interest has recently been revived in this method by 'Amateur Scientist' (1962) and by Vand, Henisch & McCauley (1963) who reported the growth of crystals of some salts of organic acids, some minerals including calcite, and some metals. There are many problems in solid-state physics which require the study of large single crystals and it seemed worth while to us to examine the possibilities of the method.

In our experiments the gels were prepared by adding either *N* acetic acid or *N* hydrochloric acid to a solution of waterglass, the density of which was varied between 1.02 and 1.08 g.cm<sup>-3</sup>. The mixture was poured into U-tubes and allowed to stand. The time required for the gel to set varied from a few seconds to a few hours; the gels used for the crystal-growing experiments were those that were nearly transparent. The gels were slightly acidic and formed plugs some four or five centimetres long in the bottom of the tubes. Copper tartrate crystals were prepared by placing a 0.5*N* solution of copper sulphate in one arm of a U-tube and a 0.5*N* solution of tartaric acid in the other arm. Several such tubes were prepared, and bright blue crystals with extremely well formed faces appeared in all of them after a few days, the dimensions of the largest crystal being 3 mm × 1.5 mm × 1.5 mm. Cadmium oxalate crystals were grown in a similar manner, the reacting solutions in this case being a 0.4*N* aqueous solution of cadmium iodide and a 2*N* alco-

holic solution of oxalic acid. Colourless crystals grew in all the specimen tubes, the largest crystals being about the same size as those of the copper tartrate.

Zero, first and second layer equi-inclination Weissenberg photographs were taken with the crystals rotating about the *c* axes. Cu *K*α radiation was used; the unit-cell dimensions were calculated from the diffraction patterns and are given in Table 1.

The densities of the crystals were measured in the standard way with a small density bottle. The observed values are compared with those calculated from unit-cell dimensions and composition of the crystals in Table 2. Copper tartrate crystals dehydrated easily when stored over calcium chloride, and by measuring the resulting loss of weight the degree of hydration was determined. The number of water molecules given in Table 2, for cadmium oxalate, is merely the number which gives best agreement between observed and calculated density.

In conclusion, it should be pointed out that, although the method works for some crystals, it does not follow that crystals of all insoluble salts may be grown in this way. Our own attempts to grow crystals of insoluble sulphides were failures and resulted only in finely divided precipitates appearing in the gels. However we do not yet know the optimum conditions for crystal growth and we feel that further research on the effect of such variables as concentration of the reactants, diffusion rates, temperature, and composition of the gel might be rewarding.

Table 1. Unit-cell dimensions

Cell parameter	Cadmium oxalate	Copper tartrate
$\alpha$	135° 52' ± 30'	97° 21' ± 1°
$\beta$	132 29 ± 30	80 43 ± 45'
$\gamma$	68 22 ± 30	115 42 ± 30
<i>a</i>	7.36 ± 0.04 Å	8.42 ± 0.07 Å
<i>b</i>	9.39 ± 0.04	12.33 ± 0.10
<i>c</i>	9.06 ± 0.04	8.82 ± 0.07

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Table 2. Observed and calculated densities (g.cm<sup>-3</sup>)

Crystal	Observed	Composition	<i>N</i> *	Calculated
Copper tartrate	2.05 ± 0.05	Cu <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 3H <sub>2</sub> O	4	2.17 ± 0.06
Cadmium oxalate	2.79 ± 0.05	CdC <sub>2</sub> O <sub>4</sub> · 3H <sub>2</sub> O	2	2.73 ± 0.05

*N*\* is the number of molecules per unit cell.

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**The permissible rotations of a two-dimensional lattice.** By EPHRAIM RAVID, *Scientific Department, Ministry of Defence, Box 7063, Tel-Aviv, Israel*

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There follows a simple proof of the well known fact that the only permissible rotations of a two-dimensional lattice are multiples of  $2\pi/n$ , where  $n=1, 2, 3, 4$ , and 6.

The proof rests on the obvious identity of the permissible values of  $n$  with the orders of those identical regular polygons which under rotation and translation can cover completely a finite plane surface. The angle between two

adjacent sides of a regular polygon of order  $n$  is  $\pi(1-2/n)$ . It is then required that an integral number  $m$  of such angles be equal to  $2\pi$ , or  $m\pi(1-2/n)=2\pi$ ,  $0 \leq m \leq \infty$ .

Dividing by  $m\pi$  we have  $2/n+2/m=1$ . The only finite, integral solutions of this equation are  $n=2, 3, 4, 6$ .  $n=1$  is of course the identity transformation.