

but which, for the same B ion, may vary with the lattice spacing in a fairly regular manner. The only quantity which seems likely to cause such effect is the presence of homopolar bonding between the B and oxygen ions. Such a suggestion has frequently been made (e.g. Eucken & Büchner, 1934; Megaw, 1947), but it has not been considered that the ferroelectricity depends primarily on the existence of such bonding, as these results suggest. The proportion of homopolar to ionic bonding would vary considerably for different ions, but if the A ion only is substituted in the structure a correlation between lattice spacing and change in Curie point might be expected. The experimental results require the ratio of change of Curie point with lattice parameter, to be positive, negative, and about zero in the titanates, tantalates, and niobates respectively.

On the other hand, the relation

$$\delta\theta \propto (1.5 - R_A) \quad (2)$$

holds within about 20% for all compounds in Table 2 with orthorhombic symmetry, and also for CaTiO_3 , which is not ferroelectric. Such a result has a reasonable interpretation if it is assumed that the internal stresses producing the shear in the different compounds are approximately the same, and are independent of temperature. The shear involves a change in the A -O, but not the B -O bond lengths, so that the restoring forces may be expected to be roughly of the form

$$1/\{(A-O) - (R_A + R_O)\},$$

reaching infinity when the ions are touching and $t=1$. This will lead to a relation of type (2).

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References

- EUCKEN, A. & BÜCHNER, A. (1934). *Z. phys. Chem. B*, **27**, 321.
 FORSBERGH, P. (1949). *Phys. Rev.* **76**, 1187.
 GOLDSCHMIDT, V. M. (1926a). *Skr. norske Vidensk. Akad., Matem.-Naturvid. Kl.*, no. 2.
 GOLDSCHMIDT, V. M. (1926b). *Skr. norske Vidensk. Akad., Matem.-Naturvid. Kl.*, no. 8.
 HULM, J. K., MATTHIAS, B. T. & LONG, E. A. (1950). *Phys. Rev.* **79**, 885.
 KAY, H. F. & VOUSDEN, P. (1949). *Phil. Mag.* **40**, 1019.
 KEITH, H. D. (1950). *Proc. Phys. Soc. Lond. B*, **63**, 208.
 MATTHIAS, B. T. (1949). *Phys. Rev.* **75**, 1771.
 MEGAW, H. D. (1946). *Trans. Faraday Soc.* **42** (a), 224.
 MEGAW, H. D. (1947). *Proc. Roy. Soc. A*, **189**, 261.
 ROBERTS, S. (1949). *Phys. Rev.* **76**, 1215.
 RUSHMAN, D. F. & STRIVENS, M. A. (1946). *Trans. Faraday Soc.* **42**, 231.
 VOUSDEN, P. (1951). *Acta Cryst.* **4**, 68.

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The crystal structure of salicylic acid. By W. COCHRAN,* *Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England*

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Salicylic acid provides one of the best examples of a substance whose physical and chemical properties indicate hydrogen-bond formation between the hydroxyl group and an adjacent oxygen atom of the same molecule. The crystal structure of this compound has been determined from a study of the Patterson function projected on the (001) and (010) planes, and of the Fourier transform of a single molecule.

The optical and morphological properties of the crystals are described by Groth (1906-19, vol. 4, pp. 453, 493). X-ray measurements show

$$a = 11.5_2, b = 11.2_1, c = 4.90 \text{ \AA}, \beta = 91^\circ.$$

The space group is $P2_1/a$. Fig. 1 shows the electron density projected on the (001) plane. The corresponding $F(hk0)$'s were measured using a Geiger-counter spectrometer, and the value of $\Sigma |F_o - F_c| \div \Sigma |F_o|$ is 0.12 at the present stage of refinement.

The association of two molecules through their carboxyl groups can be clearly seen from this projection. It is known that salicylic acid forms dimers in solvents such as benzene. ($F_o - F_c$) syntheses lead to the following conclusions. The hydrogen atoms in the 3, 4, 5 and 6 positions are represented by electron-density maxima† of about 0.8 e.Å.⁻³; the position of a similar maximum close to the oxygen of the hydroxyl group is consistent with an O-H

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† These maxima cannot be distinguished in the projection reproduced in Fig. 1.

