In table 1 we have listed the co-ordinate products corresponding to the most important material constants. In some cases numerical factors (2) enter because of the definition of the strain tensor (Voigt). Of course, the usual index of the material constants which refers to a second-rank symmetric tensor assigns the numbers 1–6 to the six products (4), in the order indicated.

Table 1. *Co-ordinate products*

Dielectric constant (ϵ)	$(x_i x_j)$
Piezoelectric constant (e)	$(x_i)_1\ (x_j x_k)_2$
Piezoelectric modulus (d)	$(2-\delta_{jk})\ (x_i)_1\ (x_j x_k)_2$
Elastic constant (c)	$(x_i x_j)_1\ (x_k x_m)_2$
Elastic modulus (s)	$(2-\delta_{ij})\ (2-\delta_{km})\ (x_i x_j)_1\ (x_k x_m)_2$
Photoelastic constant (p)	$(x_i x_j)_1\ (x_k x_m)_2$
Photoelastic modulus (π)	$(2-\delta_{km})\ (x_i x_j)_1\ (x_k x_m)_2$

The alternate definition of the strain tensor (Love, Wooster) leads to products without any numerical factors.

The rule for the transformation (2) also holds under inversion provided one supplies an extra change of sign for the material constants that do not truly transform like products of polar vector components.

The correspondence between the transformation properties of the material constants and the co-ordinate products (3) is also of great value in determining the symmetry of the scheme of material constants required by crystal symmetry.

Reference

Cady, W. G. (1946). *Piezoelectricity.* New York; London: McGraw-Hill.

Acta Cryst. (1952). **5**, 149

The crystal structure of decamethylenediamine.

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As a continuation of the study of bond-length alternation in long-chain aliphatic compounds we have examined the structure of decamethylenediamine. Being a homologue of hexamethylenediamine (Binnie & Robertson, 1950) this compound also would be expected to exhibit an alternation of carbon–carbon bond lengths. The investigation has encountered experimental difficulties. The diamine reacts with carbon dioxide and must be protected from the atmosphere. The crystals available were extremely thin plates, and as a result only a small fraction of the possible reflexions could be observed. The incompleteness of the data thus prevented any accurate determination of bond lengths. However, the approximate shape and orientation of the molecule have been found.

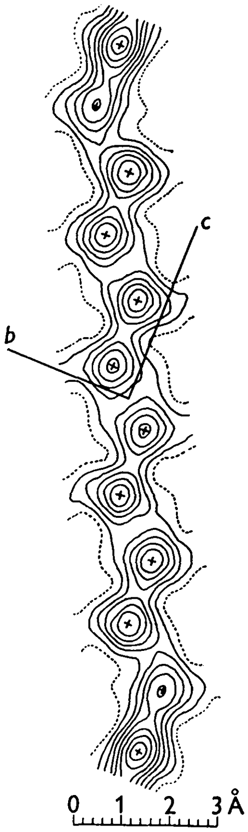

Fig. 1. Molecule of decamethylenediamine projected on (100). Contours at intervals of 1 e.Å^{-2}, the one-electron line being broken.

Decamethylenediamine is orthorhombic with

$$a=7\cdot25\pm0\cdot05,\quad b=5\cdot72\pm0\cdot03,\quad c=29\cdot4\pm0\cdot2\ \text{Å}.$$

The space group is D_{2h}^{15}-*Pbca*. The density lies between 0·88 and 1·04 g.cm.$^{-3}$, requiring four chemical molecules per unit cell.

The cell dimensions and space group indicate that the molecular arrangement in decamethylenediamine is similar to that of hexamethylenediamine (Binnie & Robertson, 1950). The similarity permitted a reasonable trial structure to be found for the (0*kl*) zone. When the Fourier projection on (100) was calculated all the carbon and nitrogen atoms were clearly resolved (Fig. 1). The new co-ordinates gave a reduced discrepancy but none of the structure factors changed sign. With the crystals available it was not possible to extend the range of measured intensities. As a result refinement could not be continued by Fourier syntheses. Nevertheless, the projection confirms the similarity to the hexamethylenediamine orientation.

No intensity data were obtained for the (*h*0*l*) zone, but it was noted that, as in the case of hexamethylenediamine, the (200) reflexion was unusually strong.

When additional attempts at obtaining larger crystals did not succeed, work was transferred to the analogous decamethylene glycol which proved more suited to the accurate measurement of bond lengths. The completion of the study of decamethylenediamine is dependent upon better methods of growing crystals.

We wish to thank Imperial Chemical Industries Ltd. for the sample of decamethylenediamine used in the investigation.

Reference

Binnie, W. P. & Robertson, J. M. (1950). *Acta Cryst.* **3**, 424.