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Note on the construction of models to illustrate theories of crystal structure.

(*With Plate III.*)

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THERE are probably few subjects for the study of which models are more indispensable than the theories of crystal structure ; but the provision of any considerable series of such models is costly, and they require, moreover, a large amount of space for storage. Some interchangeable models, which the author has lately had constructed to illustrate the space-lattices and the regular point-systems of Sohncke, and which may be fitted up and taken to pieces as required, have been found so convenient, both for lectures and for private study, that a short description of them may be found useful, although they differ only in details of construction from those suggested by Sohncke.[1]

In these models, the crystal-particles are represented by glass beads, fixed at equal distances on steel wires, which are supported, in the positions required, in a wooden frame covered with ordinary perforated zinc. The general construction of the models will be clear from an inspection of figs. 1 and 2 of Plate III, which represent, respectively, one of the space-lattices (the 'cube with centred faces') and No. 42 of the regular point-systems (the 'six-point-screw-system').

In the author's models, which are of a convenient size for a small class, the frames are 7 inches square and 1½ inches deep, and are covered on both sides with squares of perforated zinc, having ten holes to the inch. Four long steel pins, projecting from the lower side of the frames,

[1] L. Sohncke, 'Entwickelung einer Theorie der Krystallstructur,' Leipzig, 1879, p. 179, and Pl. V.

fit into holes in the upright sides of the base, to keep the frame in position and serve as guides in removing or replacing it. These pins are visible in fig. 2, which shows the frame slightly raised off the base. The beads (of the variety known as 'curtain beads') are cemented on straight steel wires, chosen so as to fit nicely in the holes in the zinc, by means of a cement made of shellac with 10 per cent. of oil of cassia.[1] Very suitable wires, conveniently pointed at one end, may be made by cutting 18-inch knitting needles (which should be nickel-plated to prevent rusting) into halves. Each wire carries four beads, set 1·4 inches apart.

Care must be taken, in selecting the zinc, to see that the squares are free from irregularities in the perforation, so that the holes accurately coincide when two squares are superposed; and also, in fixing them on the frames, to see that the holes lie vertically over one another. The appearance and usefulness of the models depend very much on attention to this and to the accurate spacing of the beads.

The holes in ordinary perforated zinc are arranged in rows at 60°, so that the frames lend themselves particularly well to the construction of models with hexagonal or trigonal symmetry; but, since the spacing of the holes in two directions at right angles is as $1 : \sqrt{3}$, or nearly as $4 : 7$, it is possible to use them also for cubic and tetragonal models.

In the compound space-lattices and point-systems, which are composed of two or more interpenetrant simple lattices, the rows of beads forming certain of the constituent lattices are brought into the proper position by raising their wires by means of a suitable false bottom or 'inlay', which is placed on the base-board and kept in position by three brass pins, over which it fits.

Some forms of such 'inlays' are shown in figs. 1 to 5. That seen in fig. 2 is made by fitting short lengths, cut from a round wooden rod, into holes in a piece of $\frac{3}{8}$-inch board. For the 'centred cube' and the 'cube with centred faces', one, or two, of the simple cubic lattices are raised on strips of wood, arranged parallel to an edge (fig. 3), or to a diagonal (fig. 1), of the base of the cube, respectively. A convenient form of 'inlay' for the compound hexagonal columnar (No. 53, cf. fig. 11) and similar point-systems, consists of a sheet of thick millboard, in which are punched holes to allow the alternate wires to drop lower than the others by the thickness of the board. An 'inlay' made on the same principle may be used, as an alternative to the form seen in fig. 2, for the screw-systems. Fig. 5 shows such an 'inlay', made of zinc, for the compound rect-

[1] R. Threlfall, 'Laboratory Arts,' 1898, p. 88.

angular two-point-screw-system (No. 6), shown in plan in fig. 9. In this, holes are drilled in appropriate positions through one, two, or all three of the plates, to allow the wires to drop through. An inlay, consisting of a sloping plate of zinc, is required for the monoclinic and anorthic models.

When setting up a model, the wires carrying the beads are first arranged in the frame, as required; the proper 'inlay' is placed in position, and the frame and wires are then lowered on to the base, guided by the steel pins.

Two strips of the perforated zinc, cut from the sheet in the two rectangular directions, and having the holes numbered to serve as scales, will be found of great assistance in setting up. So also a templet, made of a square of cardboard punched with holes in the proper positions, would, if laid on the zinc, at once indicate the holes for the insertion of the wires, and save a considerable amount of time.

All the fourteen space-lattices may be readily represented by means of the models, as may also a considerable number of the sixty-five regular point-systems. The figures (figs. 6–11) show convenient arrangements of the wires in a few typical cases.

Special varieties of the general Sohncke systems, such as the 'bees' cell structure' (a special case of the compound hexagonal columnar system), can of course also be readily constructed. The tetragonal point-systems of Sohncke (general cases) cannot, however, be very well represented by means of the models (though an approximation to them is possible),[1] while the cubic point-systems require each a separate model.

[1] If it is desired to show the tetragonal systems, a frame may be fitted with a pair of zinc plates specially drilled with holes in the proper positions for the wires. One such pair of plates, drilled for the compound tetragonal columnar system (No. 36), is sufficient to enable any of the tetragonal point-systems to be constructed.

[*Explanation of Plate*, p. 54.]

Explanation of Plate III.

Fig. 1. Model of the 'cube with centred faces' (showing the form of the 'inlay', and the dense arrangement of the particles in the octahedral planes).

,, 2. Model of Sohncke's regular point-system, No. 42, the right-handed (one-threaded) six-point-screw-system. (The frame is slightly raised to show the guide-pins and the form of the 'inlay'.)

,, 3. 'Inlay' for model of the centred cubic space-lattice.

,, 4. ,, ,, rhombohedral space-lattice.

,, 5. ,, ,, compound rectangular two-point-screw-system (Sohncke, No. 6).

,, 6. Plan of wires for model of the anorthic space-lattice. The 'inlay' required is an inclined plate of zinc, sloping downwards towards the front of the model.

,, 7. Plan of wires for model of the tetragonal prismatic space-lattice.

,, 8. Plan of wires for models of the prismatic space-lattice of 120°, and the rhombohedral space-lattice.

,, 9. Plan of wires for models of the rectangular columnar system (Sohncke, No. 5, and Nos. 6–8).

,, 10. Plan of wires for models of the hexagonal columnar system (Sohncke, No. 47), and (with 'inlays') the one-, two-, and three-threaded six-point-screw-systems (Nos. 42–46).

,, 11. Plan of wires for models of the compound hexagonal columnar system (No. 53), and the corresponding screw-systems (No. 48-52).

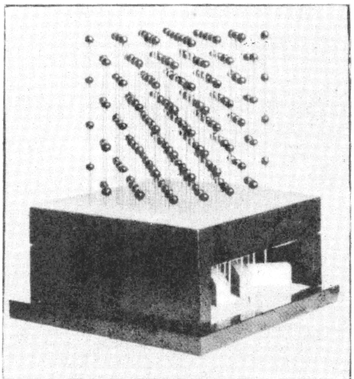

Fig. 1

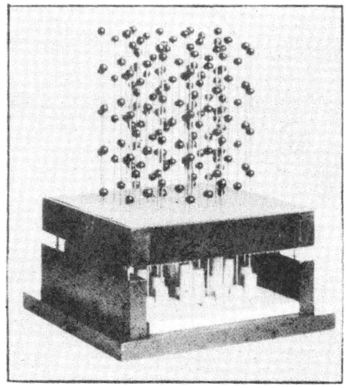

Fig. 2

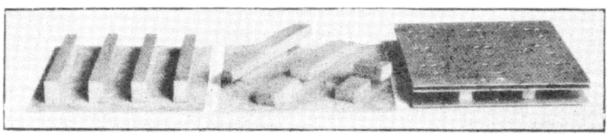

Fig. 3 Fig. 4 Fig. 5

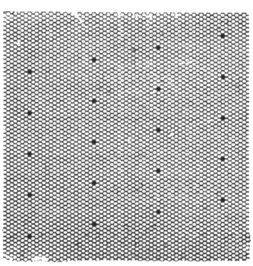

Fig. 6

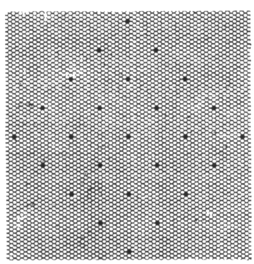

Fig. 7

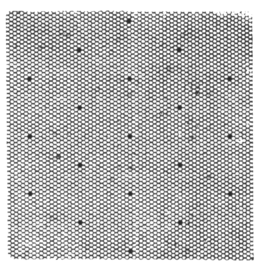

Fig. 8

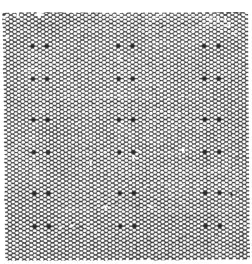

Fig. 9

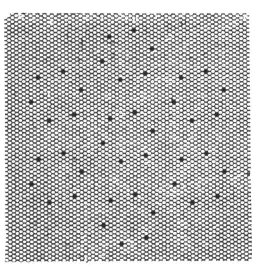

Fig. 10

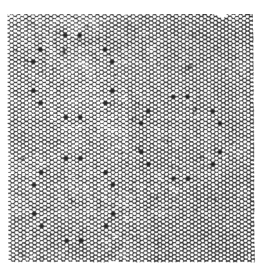

Fig. 11

H. L. Bowman: Models to illustrate Theories of Crystal Structure.