

quitenidine), although the degree of discrimination by this adsorbent for one isomer of each pair is less pronounced than for those isomers recorded in Table I. However, the discrimination is sufficient to permit assignment of configuration to be made from the results.

Efficient 'stereo-selective adsorbents' have been obtained for optical and geometrical isomers of various classes of compounds, for example, alkaloids, morphinans; details of the preparation of these adsorbents and their application in configurational analysis will be given elsewhere. Investigation of such 'selective adsorbents' as models for biological receptor surfaces<sup>3</sup> is in progress, and their use in chromatographic separations is being explored.

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<sup>1</sup> Vysotskii and Polyakov, *Zhur. fiz. Khim.*, **30**, 1901 (1956). Dickey, *J. Phys. Chem.*, **59**, 695 (1955). Haldeman and Emmett, *ibid.*, **59**, 1039 (1955). Also references cited in those papers.

<sup>2</sup> Curti, Colombo and Clerice, *Gazz. chem. ital.*, **82**, 491 (1952).

<sup>3</sup> Beckett and Casy, *J. Pharm. Pharmacol.*, **6**, 936 (1954).

### Boron Phosphide, a III-V Compound of Zinc-Blende Structure

THE application of the semi-conducting properties of germanium and silicon in devices of great technical importance has in recent years stimulated interest in the III-V compounds<sup>1</sup>. Compounds of the group III elements aluminium, gallium and indium with the group V elements phosphorus, arsenic and antimony have the cubic zinc-blende structure, which is closely related to the diamond structure of the group IV elements carbon, silicon, germanium and grey tin. The nitrides of aluminium, gallium and indium have the hexagonal wurtzite structure. The nitride of boron, the lightest of the group III elements, has a graphite-like hexagonal layer lattice.

It has been reported recently<sup>2</sup> that the General Electric Company in the United States has succeeded in synthesizing 'borazon' crystals, that is, boron nitride with the zinc-blende structure, which are said to be harder than diamond. While, apparently, very high pressures are necessary for the formation of these, we have prepared boron phosphide (BP) of zinc-blende structure by the reaction of boron and red phosphorus in an evacuated, sealed silica tube at 1,100°C. In order to limit the vapour pressure of phosphorus, the cooler end of the tube was kept at approximately 450°C., corresponding to a pressure of about two atmospheres. Analysis of the reaction product by X-ray diffraction showed a zinc-blende structure, with a lattice parameter ( $a = 4.55$  Å.) in very good agreement with the covalent tetrahedral radii given by Pauling ( $r_P = 1.10$  Å.,  $r_B = 0.88$  Å.,  $a = \frac{4}{\sqrt{3}}(r_B + r_P) = 4.57$  Å.).

Boron phosphide does not seem to have been mentioned in the literature since the end of the last century<sup>3</sup>, when the existence of BP and  $B_5P_8$  were quoted.

Traces of tungsten carbide, originating from the mortar, were present in our X-ray diffraction photographs, which indicates the high abrasiveness of BP. By analogy with borazon and diamond, one would expect BP to be harder than SiC and to have also a larger energy gap<sup>4</sup>. These and other physical and chemical properties are now being investigated.

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<sup>1</sup> Welker, H., *Z. f. Naturf.*, **7a**, 744 (1952); **8a**, 248 (1953).

<sup>2</sup> For example, *The Times*, p. 8, Feb. 14, 1957.

<sup>3</sup> Moissan, H., *C.R. Acad. Sci., Paris*, **113**, 624, 726, 737 (1891). Besson, A., *ibid.*, **113**, 78 (1891).

<sup>4</sup> Herman, F., *J. Electronics*, **1**, 103 (1955).

### Use of Organic-Montmorillonite Compounds in Gas Chromatography

THE development of the various forms of gas chromatography has resulted in a search for more selective stationary phases and adsorbents. In partition chromatography there appears to be a limit to the selectivity which can be obtained with solution forces, for as yet no stationary phase has been found which will separate close-boiling isomers such as meta- and para-xylenes. As it is to be expected that surface forces would show more selectivity, adsorption chromatography appears the most promising technique for these difficult separations. In this respect the recent work of Janak<sup>1</sup>, in which he uses zeolite as an adsorbent, is interesting. This mineral has a three-dimensional lattice with replaceable cations, and a certain amount of variation in the separation characteristics may be achieved by replacing the naturally occurring sodium ions by silver or manganous ions.

In a similar manner montmorillonite has replaceable cations; but in addition an expansion of the lattice can occur in the *c*-axis, so that the sodium ions can be replaced by large organic cations, such as amines and aromatic bases<sup>2</sup>. As the cation exchange capacity of any one montmorillonite is constant, the area of the clay covered by organic material is dependent upon the size of the ion, and can vary from 30 per cent covered with the tetramethyl ammonium ions<sup>3</sup> to total coverage with dimethyl dioctadecyl ammonium ions. It follows from this that it is possible to vary the following characteristics of these organo-clay compounds. (1) The amount of the clay surface covered by the organic ion. (2) The *c*-axis spacing of the lattice (this is partly dependent upon (1)). (3) The type of organic base, aliphatic aromatic, etc., and where other functional groups are present in the basic molecule these will be spatially localized. Thus, starting from montmorillonite, it is possible to prepare a large range of adsorbents the surface structure of which is known, which should greatly facilitate the study of separation by surface forces.

Preliminary experiments with a montmorillonite totally covered with the paraffinic chains of a quaternary ammonium compound have confirmed the expectations outlined above.

Table I shows that a good separation is obtained between the paraffins and aromatics, but rather