

solution, there would have to be assumed a third thing between crystal and molecule. No evidence of such a thing was given, except by the osmotic phenomena." The author readily acknowledges the validity of Dr. Guertler's argument, and would say that the necessary evidence for the existence of such a third force is furnished by the osmotic phenomena of liquid and solid solutions, phenomena which are closely related to the laws of gaseous pressure. It is, of course, less easy to experimentally show the existence of osmotic pressure, by means of diffusion through a semi-permeable wall, as in the case of aqueous solutions; but magnitudes which are proportional to the osmotic pressure are furnished by the depression of transformation points brought about by the presence of foreign substances in solid solution. The author regards osmotic pressure as a pressure which exists between the particles of solute and solvent. It would appear that, in the case of aqueous solutions, osmotic phenomena are produced by the pressure exerted upon the water by the particles of solute, which results in an actual expulsion of part of the water. The author uses the word "particle" advisedly, because it conveys no definite idea as to size or molecular aggregation. From the foregoing reasoning, the conclusions at which the author arrives are:—

1. That gaseous, liquid, and solid solutions are members of the same family, the different states of these members being due to the differences in their molecular aggregation.

2. In all cases of true solution the molecules of each component remain unchanged—i.e., there is no association of dissimilar molecules—e.g., there can be no association of the molecules of a salt with those of water, when in the form of an aqueous solution, unless it results in the formation of a new compound. Thus in the case of gaseous solutions a uniform composition is maintained by the physical forces existing between what may be regarded as simple molecules; in liquid solutions a constant composition throughout the mass is maintained by the forces existing between dissimilar groups of molecules, but each individual group consists of only one kind of molecule. In the case of solid solutions, equilibria are maintained between the very small crystals of each component metal or intermetallic compounds.

3. With the expression  $F = C + 2 - P$  representing the phase rule, solutions come under the head of homogeneous equilibria, but that equation should not be applied to disprove the author's conception of the internal nature of solutions, because, with it, the assumption is tacitly made that a solution is homogeneous, and thereby judgment is passed before the evidence is considered.

4. From a general point of view the term "solid solution" is to be preferred to "mixed crystals," but, whichever term is used, the author considers that such bodies consist of extremely small crystals of two or more metals or intermetallic compounds; and whilst these crystals are ultra-microscopic, they retain their individual properties.

With regard to the practical aspect of this interesting question, the author will only say that with this conception, and, so far as he is aware, with this only, can the discontinuity in the mechanical properties of the  $\alpha$  brasses (discovered by Bengough and Hudson) which occur at 470 deg. Cent. be explained. Further, many other facts which are still not understood become quite reasonable after accepting this theory.

It will be seen that this note deals more with the bearing of the phase rule upon the question; other less vital objections have for the moment been left out of consideration, because the author believes they were made as a result of some slight misunderstanding, and also because it is first necessary for members interested in the subject to decide whether they will accept the author's theory as being in agreement with well-known physical laws.

## THE TIN PEST.

The adoption of a designation like "tin pest" seems to suggest that metals, like living beings, may be subject to infective diseases. That will appear absurdly fanciful to those who believe in a definite boundary-line between the living and the non-living, and may not be approved of by others, who feel less sure of the existence of such a boundary, but who would not compare a living organism built up of many compounds, constantly undergoing changes, with a metal or other elementary substance, which is uniform in its mass and endowed with certain permanent qualities. Yet Professor Ernest Cohen, of Utrecht, did not act without reason when he designated the peculiar decay of tin—which probably does not stand alone in this respect—by the name of a plague or pest. He has carefully investigated the phenomenon, and he has succeeded in demonstrating that the decay of tin can be prevented and cured. Tin should not be exposed to cold, to put the matter briefly. The subject is of considerable interest to engineers, and for this reason Professor Cohen's discourse on "The Allotropy of Metals," delivered at the Faraday Society, deserves attention.

The main facts of the decay of tin were recognized forty or fifty years ago. O. L. Erdmann noticed in 1851 that some organ pipes in the castle church of Zietz (Prussian Saxony) were decaying; he thought that the concussions to which the pipes were subject might, under certain conditions, cause a mechanical disintegration. When Fritzsche was consulted upon some peculiar Banca tin in February, 1868, by a St. Petersburg firm, Erdmann's observation had been forgotten. Some blocks of the bright white Banca tin—a very pure material—which had been kept in the customs-house sheds during the winter, had turned into a dull grey powder, and had begun to crumble. It was ascertained that the case was not isolated; tin buttons for military uniforms had changed into shapeless lumps, for instance. Fritzsche suspected the cold of the severe winter, and experiments convinced him of the correctness of his assumption; the storekeepers in a drug firm, he found out subsequently, had long known that tin should not be exposed to the cold. When Fritzsche heated the grains of his grey tin in hot water, it became bright again, and contracted at the same time; whether the heat was dry or wet did not matter. On the other hand, white tin, cooled artificially, became brittle and grey, expanding at the same time. When the grey tin was fused it changed into ordinary white tin again, and the transformation could be repeated. Fritzsche thus proved that decayed tin is not bad tin; yet, after the organ-pipes of a church in Ohlau, Silesia, which had been restored in 1837, were found badly corroded and full of holes in 1884, organ-builders did not consider such tin a suitable raw material for making new pipes, and the manufacturers of art objects shared this prejudice.

Professor Cohen's attention was first drawn to the matter when a badly-corroded 25-kg. block of tin was returned by a Moscow firm to Rotterdam because an adulteration was suspected. The tin was found to be very pure, containing not more than 0.05 per cent. of impurities. Experimenting with it, Professor Cohen confirmed and extended the observations of Fritzsche, and he demonstrated that the case of white and grey tin is entirely analogous to that of ice and undercooled water.

With the aid of his transition cell, Professor Cohen has proved that the transition temperature of tin is 18 deg. Cent. The transition cell is a glass vessel of H form. A few grammes of grey tin are brought into each limb, a solution of pink salt is poured over the tin, and platinum wires in glass capillaries are inserted into the limbs. When the one limb is heated by being dipped into warm water, while the other limb is kept cold, the grey tin in the warm limb turns