GI-MS46-O5

Early contributions of crystallography to the atomic theory of matter

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Efforts to explain the morphology of the crystals and their anisotropic properties played a basic role in investigating the "inside" structure of the matter. In 1665 R. Hooke (1635-1703) was able to explain the external shape of some crystals by relating it to close packing of spheres; the discovery in 1669 of double refraction in calcite by R. Bartholin (1625-1698) brought C. Huygens (1629-1695) to propose, in 1690, a structural model of this mineral based on packing of ellipsoids.

One century later R.J. Haüy (1743-1822) opened the way to modern crystallography and theories on the atomic structure of matter proposing that the structure of crystals is based on periodic arrays of integrant molecules [1]. In early XIX century, F.S. Beudant (1787-1850) and W.H. Wollaston (1766-1828) observed co-crystallization of compounds with "similar" chemical formulae and E. Mitscherlich (1794-1863) introduced the term isomorphism to indicate the close similarity of the crystals formed by compounds that can co-crystallize [2].

The above mentioned theoretical models and experimental results, obtained in the field of crystallography, played a crucial role in solving a basic question debated for about one century and aiming to establish a distinction between the "particles" that nowadays are known as atoms and molecules. Comparing two isomorphous compounds that differ in composition only for the nature of one chemical element (e.g., an arsenate and its analogous phosphate), Mitscherlich successfully determined the atomic weight of elements, thus supporting a necessary distinction between atoms and molecules.

A. Avogadro (1786-1856) knew very well the results achieved by crystallography, as testified by his four-volume treatise of physics published in 1837-1841. In fact, he dedicated the first volume of this treatise to the science of crystals. In particular, he gave great emphasis to Haüy's work of which he published the figures that show how the morphology of the crystals can be explained on the basis of an internal periodic array of particles named integrant molecules, a wording adopted by Avogadro [3]. Nowhere, in his numerous scientific and private writings, Avogadro mentions that he was inspired by Haüy's work. However, it looks hard to exclude that the image of integrant molecules filling crystals contributed to the formulation of Avogadro's hypothesis that, under the same conditions, equal volumes of gases contain an equal number of particles.

References:

[1] Haüy, R.J. (1784). Essai d'une théorie sur la structure des cristaux. Paris, France.
[2] Mitscherlich, E. (1818-1819). Abhandlungen der Königlichen Akademie der Wissenschaften in Berlin, 1818-1819, 427-437.
[3] Avogadro, A. (1811). Journal de Physique, de Chimie et d'Histoire naturelle, 73, 58-76.

Keywords: Haüy's theory, Isomorphism, Integrant molecule

GI-MS47 How to… take your next steps in crystallography

Chairs: Dr. Andrew Maloney, Dr. Chiara Massera

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Evolution of materials science. The crystal structure now central to drug product development

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This presentation will share the experience of a founding member of the Materials Science group at Pfizer, Sandwich; with a focus on the changes that have occurred within the drug product development process over the last few decades.

The Materials Science group was established, at the Pfizer UK site in the early 1990's. From one perspective it could be said that the focus still remains the same; to deliver a stable, crystalline solid form, so providing acceptable attributes that enable delivery of a reliable drug product to the patient. However, significant changes have occurred, in those early days the crystal structure was not even considered, now it is at the core of the materials science discipline, central in experimental design, insightful when trouble shooting and fundamental to the application of computational tools.

Less routine examples of how the crystal structure was key in explaining solid form properties will be presented; highlighting how this directly influenced decisions and provided confidence in progression of candidates.

Keywords: solid form, drug product development, crystal structure