13-Defects, Microstructures and Textures

MS-13.01.02 "GRAPHENE TEXTURES: TUBULES AND WHISKERS RELATED TO FULLERENE CRYSTALLOGRAPHY"
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Since the discovery of the fullerenes with their "master" molecules C60 and C70, a wealth of scientific research has been devoted to these pure carbon molecules, structures, and textures, so much different from the well-known graphite and diamond-based structures and materials.

The present review will report crystallographic aspects derived by electron microscopy, electron diffraction and also HRTEM of the growth and structure of graphite tubules and of conical graphite whiskers in relation with the fullerenes.

Crystallography and electron diffraction study of tubules. During the preparation of C60 and C70 sometimes the soot contains other carbon-based products such as graphic tubules, spheres, onions with possibly fullerene-related structural features or textures. S.ijima [Nature 354 (1991) 56] reported the existence and a study by electron microscopy and high resolution imaging of the tubules which he interpreted an coaxial small ended cylindrical tubes. D. Ugarte [Nature 359 (1992) 707] also reported a HRTEM-study and growth considerations of tubules and onion textures.

A thorough study by electron diffraction of these tubules enabled further interpretation on the construction and growth characteristics. [X.F. Zhang, X.B. Zhang et al. to appear in J.Crystal Growth (1993)]. From reciprocal space considerations of the tubule texture, diffraction features are predicted and compared with the diffraction patterns obtained under various orientations of the tube axis with respect to the incident beam. It is found that the tubules consist of a complex succession of concentric tubes of cylindrically bent graphene layers with various but discrete helicities containing also non-helical members. The helicity can be related with the beam direction of the graphene layers into tubes and a growth mechanism could be proposed. The image features in high resolution in particular concerning the nonhelical tubules could be confirmed by simulation of suitably modeled texture proposed.

Helical graphite whiskers

Conically structured graphite whiskers found under similar conditions of formation as those for fullerenes containing soot present unusual features in the electron diffraction patterns taken along the whisker axis. [S. Amelinckx et al. J.Crystal Growth 121 (1992) 543] The fragments of the easily cleaved whiskers have conically shaped ends with an obtuse top and reentrant bottom angle of about 140°. The electron diffraction patterns of disc-shaped thin fragments exhibit circulate rings of equispaced spots. The spacing is variable but discrete, depending on the type of whisker. A growth mechanism is proposed whereby the initial graphene layer adopted a slitted dome configuration obtained by inserting a fivefold carbon ring in the sixfold network. Successive sheets are rotated with respect to the previous ones over a constant angle, thus realising a helical cone around a "disclination" with a fivefold carbon ring core. This model explains the morphology and the diffraction effects of these columnar graphite crystals. The growth mechanism has a direct relationship to the formation of the "bucky ball" molecules.

MS-13.01.03 HREM STUDY OF APERIODIC SOLIDS RELATED TO THE ARCHIMEDEAN SPIRAL BY S.A. Bursill, Feng Julin and Pan Xubiao, School of Physics, University of Melbourne Parkville, VIC 3052, Australia.

The concept of spiral lattice was applied to some known mineral structures by Bursill, J. Mod. Phys. B., 2197-2216, 1980. These include clino-sasbestos, bellogite (a clay) and cylindrite is sulphide.

Further examples of synthetic and natural solids related to normal crystals via conformal transformations, are found in sulphide catalyst particles as well as some derivatives of graphitized carbon, including nanotube variants.

Some recent results of high resolution electron microscopic studies of this family of aperiodic solids are presented.

MS-13.01.04 STRUCTURAL ANALYSIS BY ELECTRON DIFFUSE SCATTERING. By Yimei Zhu.
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YBa2Cu3Ox superconductors undergo a structural transition (from twin to twined) when oxygen levels are sufficient depleted or a small fraction of the Cu atoms is replaced by certain tri-