

Carbon Nanotubes: Discovery, Impact and Beyond

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Discovery in science has never been made without a specific research background. The case of carbon nanotubes (CNT) is not an exception. I would like to present how the nanotube was discovered after a long research career of my own. In 1991, the carbon nanotubes were presented for the first time in a convincing and scientific way [1], however most of people don't know what I was doing before the discovery. For this question, I would like to answer with an emphasis of the importance of ample experiences with high resolution transmission electron microscopy (HRTEM) that made possible to provide with various nanostructured materials [2]. There will be no chance for finding such a nanoscale structure of the carbon nanotube without this tool and technique. I was lucky in this sense.

The carbon nanotubes brought us dual excitements in both academia and industry as fundamental condensed matter physics and industrial applications. It is interesting in noticing the citation numbers for the first paper reporting CNT in Nature in 1991. The number became over 44,000 now that were doubled in the last two years. It means that so many researchers are working still on this material after 26 years of the discovery.

CNT, chrysotile asbestos, imogolite [3], and many structures in biological systems are known to have tubular structures, resulting from anisotropic growth in one particular orientation. In the case of CNT, the presence of catalytic metal particles in the tubule formation appears to control a tubular morphology. In general, the formation of nanometer-scale tubular structures is caused mostly by molecular conformation of a building block unit or a total energy minimization of the tubular structure system.

We have recently examined aluminum oxy-hydroxide gamma-AlOOH, boehmite, which has been known to form into a variety of morphologies from a fibril, low-dimensional sheet, platelets, to bulk crystal, depending on a synthesis process. One of them is a quasi-one-dimensional fibril structure, which grows in an aqueous solution as a sol form. We have studied detailed morphology of this fibril boehmite and found that the fibril grows selectively parallel to the c-axis and does not form in a tubular structure but a nanometer-sized ribbon [4]. Electronic band structures of such a ribbon have been studied and showed interesting size-dependent band gaps [5]. The growth was not promoted by a particular catalytic substance so that such an anisotropic growth should be originated from the boehmite structure itself and surroundings.

Reference:

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