

Indian chemistry on the fullerene bandwagon

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What are the allotropic forms of carbon? Even a high school student would probably be ready with the answer—diamond and graphite—and probably add that the former is glamorous and sparkling, while the latter is dull and lustreless. In recent years the graphite Cinderella has been transformed, first by laser ablation and later by contact arc vapourization in an inert atmosphere into a new class of chemical stars—the fullerenes.

First observed mass spectrometrically by the groups of Harold Kroto and Richard Smalley in 1985, these closed carbon clusters now constitute a new class of carbon allotropes. C_{60} , the first well-characterized member of the fullerene family, has the, now familiar, soccerball structure, reminiscent of the geodesic dome of Buckminster Fuller, who unfortunately did not live to see his architectural creation appear in the unlikely realm of chemistry. Christened as buckminsterfullerene, the C_{60} structure has adorned, in the last year or so, the covers of *Science*, *Nature* and *Scientific American* (and even *Current Science*, 25 December 1991 issue). Declared as the molecule of the year in 1991 by *Science*, C_{60} has been the subject of the most intense investigation.

The sudden surge of interest in the fullerenes has been made possible by the 1990 discovery of Krätschmer *et al.* (*Nature*, 1990, 347, 354), that these carbon clusters can be prepared in reasonably high yields by a relatively simple procedure. The last two years have seen an explosion in the number of papers published on all aspects of fullerene science ranging from chemical reactions of these carbon cages, esoteric theoretical calculations and, of course, superconductivity of doped fullerenes. While C_{60} is the best investigated member of this family, new carbon clusters are characterized with amazing

frequency. It is not surprising, therefore, that researchers from diverse disciplines have flocked to prospect this virgin territory; the scramble for results and publications reminding one of the feverish staking of claims during the California gold rush.

Carbon chemistry is presumably neutral ground and consequently the prospectors have included organic, inorganic, physical and theoretical chemists, a smattering of materials scientists and even the odd, chemically inclined, renegade physicist. Ironically, the discovery of C_{60} was not motivated primarily by chemical concerns, but by astrophysical questions regarding interstellar carbon. Much of the C_{60} excitement has been centred in the United States, a land of instant fashions. The rest of the world (including paradoxically Harold Kroto's home country, England) have been overshadowed by the flood of American publications (see *Accounts of Chemical Research*, 1992, 25, 98–175). It is therefore refreshing to see that the May 1992 issue of the *Indian Journal of Chemistry* is a special, combined rendering of both the inorganic/physical (Section A) and organic/medicinal chemistry (Section B) sections, reflecting the Indian contribution to this fast developing chemical frontier. To this reviewer, fullerene research in India already seems to have catalysed a very desirable transformation, viz. the integration of the different areas of chemistry and most notably the unification (albeit briefly) of the two arms of the *Indian Journal of Chemistry*.

The issue contains 15 articles, which have not been further classified into original papers and reviews, making it difficult sometimes to recognize a new result.

Over half the articles emanate from a single institution (Indian Institute of Science, Bangalore), a clear indication of a concentration of effort. The slant of the articles is overwhelmingly towards physical and theoretical aspects with organic and organometallic chemistry being poorly represented. This undoubtedly reflects the special difficulties (in the Indian context) of characterization of new compounds of relatively high molecular masses. The limited (almost negligible) use of mass spectrometry and HPLC in most of the experimental

papers, is a testimony to the limited analytical methodology that is routinely accessible. In some cases the Indian work only repeats what has already been reported. Nevertheless, there is much of interest to the fullerene connoisseur in this issue—the possibility of endohedral metal complexes of C_{60} , new species containing only carbon and nitrogen, convenient procedures for isolation of fullerenes and several elegant discussions of electronic structure, bonding and superconductivity. This issue should transmit, to a wide audience of Indian chemists the excitement in the area of fullerene research and maybe it will draw more members of the Indian research community into this field.

There is however one nagging question that remains in the mind of this reviewer. There have been other molecules with dramatically useful properties, which posed many challenging chemical problems. Rarely did they generate the kind of hoopla associated with the fullerenes. What then makes the fullerenes so special? Is it the extraordinary symmetry of their structures, which paradoxically masks chemical complexity behind a cloak of apparent structural simplicity? Is it the realization that something as mundane as carbon can still generate scientific excitement? Or is it that chemistry, long overshadowed by the sudden discoveries in physics (ca. superconductivity) and the continued molecular triumphs in biology and recovering from the fiasco of cold fusion, now needs a morale booster?

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Microbiology reviews

Annual Review of Microbiology 1991. Vol. 45. L. N. Ornston, A. Balows and E. P. Greenberg, eds. Annual Reviews Inc., El Camino Way, Palo Alto, California, 94306, USA. 1991, 657 pp. Price USA \$41, elsewhere \$46.

The autobiographical article in this volume is by Ralph S. Wolfe, who did

pioneering work on methanogenic bacteria and their biochemistry, especially the aspect dealing with their coenzymes. The next article, 'Serine β -lactamases and penicillin-binding proteins' by J. M. Ghuysen, deals with the important problem of bacterial resistance to penicillin, the mechanisms of resistance, and clues to synthesis of deriving penicillin compounds that are not inactivated by β -lactamases or penicillin-binding proteins.

An article of great interest to molecular biologists and environmentalists is 'Polymerase chain reaction: applications in environmental microbiology' by R. J. Steffan and R. M. Atlas. The authors describe details of the polymerase chain reaction (PCR) and its use not only to detect microorganisms in environmental samples but also to isolate and clone specific DNA sequences. They point out that PCR permits cloning and sequencing of genes even from environmentally important microorganisms that cannot yet be cultured.

'Techniques for selection of industrially important microorganisms' by D. B. Steele and M. D. Stowers deals with the development of primary screening techniques during the past two decades through modifications of classical techniques, coupled with advances in the basic understanding of microbial physiology and growth, and also with an important aspect of biotechnology.

Chaperones, which function in protein folding, oligomerization and export of proteins in biological systems, especially bacteria, have of late become very important in biological studies. Three articles deal with this subject: 'The universally conserved groE (Hsp60) chaperonins' by J. Zeilstra-Ryalls, O. Fayet and C. Georgopoulos deals with chaperones found in chloroplasts, mitochondria and prokaryotes; 'Chaperone-assisted assembly and molecular architecture of adhesive pili' by S. J. Hultgren, S. Normark and S. N. Ab-

raham reviews work on the assembly of bacterial pili involving specific molecular interactions between structural and chaperone proteins; 'Proper and improper folding of proteins in the cellular environment' by B. Nilsson and S. Anderson describes the general role in folding by hsp70, Dnak and hsp60, GroEL molecular chaperone families, and the role of factors such as peptidyl proline isomerase protein disulphide isomerase, thioredoxin and Sec B, which interact with unfolded forms of specific classes of proteins.

Does *E. coli* possess a conventional reverse transcriptase? What is the function of this enzyme in bacteria? These interesting questions have been discussed in the review 'MsDNA and bacterial reverse transcriptase' by M. Inouye and S. Inouye. The existence of retroelements in prokaryotes, molecular mechanisms of multicopy single-stranded DNA (msDNA), functions and roles of msDNA in cells, and the requirement of reverse transcriptase for msDNA synthesis have been adequately reviewed in this article.

Virologists and ecologists will find the article 'Genetically engineered baculoviruses as agents for pest control' by H. A. Wood and R. R. Granados very useful. From an environmental and healthy standpoint, baculovirus pesticides are outstanding alternatives to synthetic chemical pesticides, but the field performance and production costs of the former have at present limited their use. These limitations are slowly being removed.

No review in microbiology is nowadays complete without an article on human immunodeficiency virus (HIV). 'Regulation of human immunodeficiency virus replication' by B. R. Cullen focuses particularly on viral and cellular factors involved in regulation of HIV type 1. The application of this information to the discovery of effective approaches to chemotherapeutic intervention in HIV-1-induced disease is likely to remain a

major focus of biomedical research in the future.

'Hepadnaviruses and hepatocellular carcinoma' by A. H. Sherkev and P. L. Marion discusses the mechanism by which these viruses, of which hepatitis B virus is an example, induce cancer of the liver. A complex interplay of regenerative cell growth induced by hepatic inflammatory disease, molecular aspects of viral integration and chromosomal alterations, and genetic and environmental host factors may participate in the development of the malignant phenotype.

'Mechanisms of natural resistance to human pathogenic fungi' by J. F. Murphy discusses how natural resistance mechanisms and immune defences regulate each other through cytokine networks.

'Nuclear fusion in yeast' by M. D. Rose discusses current research to identify the components responsible for one microtubule-dependent process, nuclear fusion (karyogamy), in the yeast *Saccharomyces cerevisiae*.

'Ivermectin as an antiparasitic agent for use in humans' by W. C. Campbell should be of great interest to parasitologists and health workers. WHO is at present distributing the drug ivermectin in Nigeria, where it has been used successfully against filaria. The review deals with its use against other intestinal parasites like hookworm and *Ascaris*, and with hospital-based trials in many countries in Africa.

Other reviews include 'Biochemical diversity of trichloroethylene metabolism', 'RNA editing in trypanosomatid mitochondria', 'Plant genetic control of nodulation', 'Gene amplification in *Leishmania*' and 'Prokaryotic osmoregulation'.

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