

## Architecture in NanoSpace

Harold Kroto

*The Florida State University, U.S.A.*

As chemistry and physics at one borderline and chemistry and biology at the other begin to become indistinguishable, multidisciplinary research is leading to the fascinating "new" field of nanoscience and nanotechnology (N&N – not to be confused with M&M). Ingenious strategies for the creation of molecules with complex exactly-specified structures, as well as functions, are being developed – basically molecules that do things can now being made. In fact, N&N may be considered the frontier chemistry of the 21st century.

When the molecule  $C_{60}$ , Buckminsterfullerene, and its elongated cousins, carbon nanotubes (or "Buckytubes"), were discovered, it suddenly became clear that our previous understanding of the structural and dynamic factors governing carbon chemistry at nanometer scale was wrong. New experimental vapour and condensed phase approaches, often involving metal cluster catalysis, have led to the production of novel refractory nanostructures. Studies of composites involving these new materials are beginning to exhibit interesting advanced materials behaviour. Fascinating fundamental insights into their formation mechanisms have also been revealed and the creation of nanoscale devices, which parallel devices used in standard engineering, are now being made.

On the horizon are numerous exciting possible applications in diverse areas, ranging from civil engineering to advanced molecular electronics, that promise to transform our lives and global economics. We now know we should one day be able to build buildings so strong that they will survive earthquakes and aeroplanes so light that they will be able to glide to safety if the engines fail. We should be able to construct supercomputers that will fit in a wristwatch and surgical techniques which will enable us to carry out medical operations almost non-invasively. If these prospects are to be realised, however, a paradigm shift in synthetic control strategies will be necessary to create really large molecules with accurately defined structures at the atomic level. This presents one of the greatest technical challenges for 21st century chemists. From a fundamental research strategy viewpoint it is worth noting the fact that the original  $C_{60}$  discovery experiments were carried out as a consequence of earlier molecular spectroscopy/radioastronomy discoveries relating to material in interstellar space and red giant carbon stars, together with the development major advances in our techniques for studying small refractory clusters.