RADIOCHEMICAL APPROACHES TO FULLERENE CHEMISTRY

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Nuclear and radiochemistry offers special and attractive possibilities for exploring the fascinating world of closed-shell carbon cages called fullerenes. This review presents a panoramic view on the use of radioactivity, nuclear irradiation and instrumental nuclear techniques in the elucidation of the structure and composition of fullerenes and their compounds.

It came as a surprise to the chemical world that somewhere between diamond, the hardest material known, and graphite, one of the softest, there was lurking a third allotrope of carbon. This ordered molecular form of carbon can be considered the strangest one yet imagined. In 1985 KROTO, SMALLEY and co-workers discovered that the laser ablation of a graphite target in vacuum produced a family of stable all-carbon cage molecules. These were dubbed buckminsterfullerenes, or more affectionately buckyballs because the shape of one of the most stable forms, the C_{60}, mimics the leather patchwork of a soccerball, and also because it conjectured similarity in form to the geodesic domes promoted by the crackpot-inventor Buckminster Fuller (1895–1983).

Part of the surprise of chemists with these new ordered molecular forms of carbon came from the fact that they have known about other forms of carbon, they have “believed” to the amorphous for a quite long time (e.g. soot, carbon black, charcoal, activated carbon, etc.). However, in 1990 KRÄTSCHMER, HUFFMAN and co-workers have unexpectedly discovered that fullerenes can be produced by solvent extraction from an amorphous graphite soot generated during the arc combustion of graphite electrodes in a low pressure (~150 torr) helium atmosphere. This has opened up an exciting new area of research in almost all fields of the natural sciences. Fullerenes have already aroused considerable attention among researchers in various fields, including astrophysics, chemistry, physics, materials
sciences, biology, and environmental science. A series of comprehensive
monographs are detailing the already achieved results.3-9

The explosive growth of the field has been interpreted as an intellectual
epidemy10 and is best reflected in a comprehensive, computer based bibliography.11

In this paper we present a review on the various radiochemical approaches and
techniques which were used in fullerene research as outlined in Fig. 1.

Fig. 1. A schematic view on the uses of nuclear and radiochemical techniques for investigating fullerenes
and related compounds

**STRUCTURAL STUDIES**

**Solid fullerenes**

*Positron annihilation*

The use of positron annihilation technique to the study of the solid state structure
of large free volumes and of lattice defects in solids has contributed an important
amount of valuable information.12 A positron implanted in a solid eventually
annihilates with an electron, producing annihilation gamma-rays. The lifetime of
positrons in solids reflects the density of electrons where the positron annihilates.