

## SOCCER BALL MOLECULES

All of us have seen the soot that is deposited on a surface which is kept near a candle flame; soot that is normally seen as a nuisance. Surprisingly, scientists have found, what has been described as the 'universe's most controversial molecule', in this very soot!

Scientists in Heidelberg, Arizona and Houston have recently reported isolating a form of Carbon which is remarkable in its properties and structure. Starting from graphite (the material used in making pencil leads) and using lasers to vaporize it in a jet of Helium gas, they have obtained samples of this material. This material is the third pure form of Carbon, the other two being graphite and diamond.

What exactly is this molecule and why are the scientists so excited about it? The molecule is a collection of 60 Carbon atoms arranged in soccer ball shape. Just as on a soccer ball, the seams form hexagonal shapes, this molecule looks similar. It has been called Fullerene by its discoverers, after Buckminster Fuller, the visionary American engineer, philosopher, scientist. It was Fuller who revolutionized engineering by his innovative use of symmetric structures. His most famous design is the geodesic dome, a hemispherical like structure made from triangular elements, which is remarkably cheap and yet very robust. Fuller had also shown that one could build soccer ball like structures using pentagons and hexagons as elementary units.

What is unusual about this molecule is its high degree of symmetry. In fact, it can be shown theoretically that this shape is the most symmetric shape that can be obtained in three dimensions. It is indeed the most symmetrical molecule, or as one of its discoverer says, 'the roundest of all molecules'. Because of its extraordinary symmetry, it is also highly stable. It is the unique arrangement of the carbon atoms in the Fullerene molecule which is responsible for its remarkable properties. Just as different molecular structure causes a world of a difference between the properties of graphite (which is so soft that it is used for lubrication) and diamond (which is the hardest natural substance known to us) even though both are basically carbon, the Fullerene form of carbon is also distinctive. The properties of this form of Carbon are still being researched but already there is a tremendous excitement among the scientists.

It is not only the scientists that are excited about this discovery. Industry is also watching these developments closely. This substance could have potential uses ranging from superconductivity to lubricants. Initial results indicate that this material used with potassium could be a very versatile superconductor. Recent advances in high temperature superconductivity, where certain ceramic materials display zero resistance at 'high' temperatures (about -100 Centigrade), have not found industrial applications because it is very hard to make bulk samples of these materials. Fullerene compounds on the other hand, are much easier to manufacture in bulk. Transmission wires made from these materials could result in savings of 20-25% power which is lost as transmission losses in conventional wires. These could also make big superconducting

magnets cheap and practical leading to a revolution in a variety of technologies, from particle accelerators to magnetic levitation mass transit systems.

Another area where much work is going on is microelectronics. These compounds seem to have properties very similar to those of gallium-arsenide, the current favorite of semiconductor manufacturers. The advantage of these materials is their low cost and the fact that they are easy to manufacture. They could replace gallium-arsenide in the new generation of semiconductors which would lead to a mini revolution in the field of electronics. Solar power promises to be the only safe and renewable energy source. The stumbling block in its widespread use is the high cost of solar cells which are currently made from amorphous silicon. Fullerene compounds have the potential of replacing amorphous silicon, bringing the target of cheap, solar power closer. Lubrication is another area of research. Fluorinated Fullerenes could replace teflon as the world's best lubricating material.

From solar cells to better and cheaper electronics, the list is long. Understandably, industries are eagerly jumping on to the Fullerene bandwagon. If even some of the products are realized, it will revolutionize our everyday life. These compounds could be to the coming decades what plastics were to the fifties and the sixties.