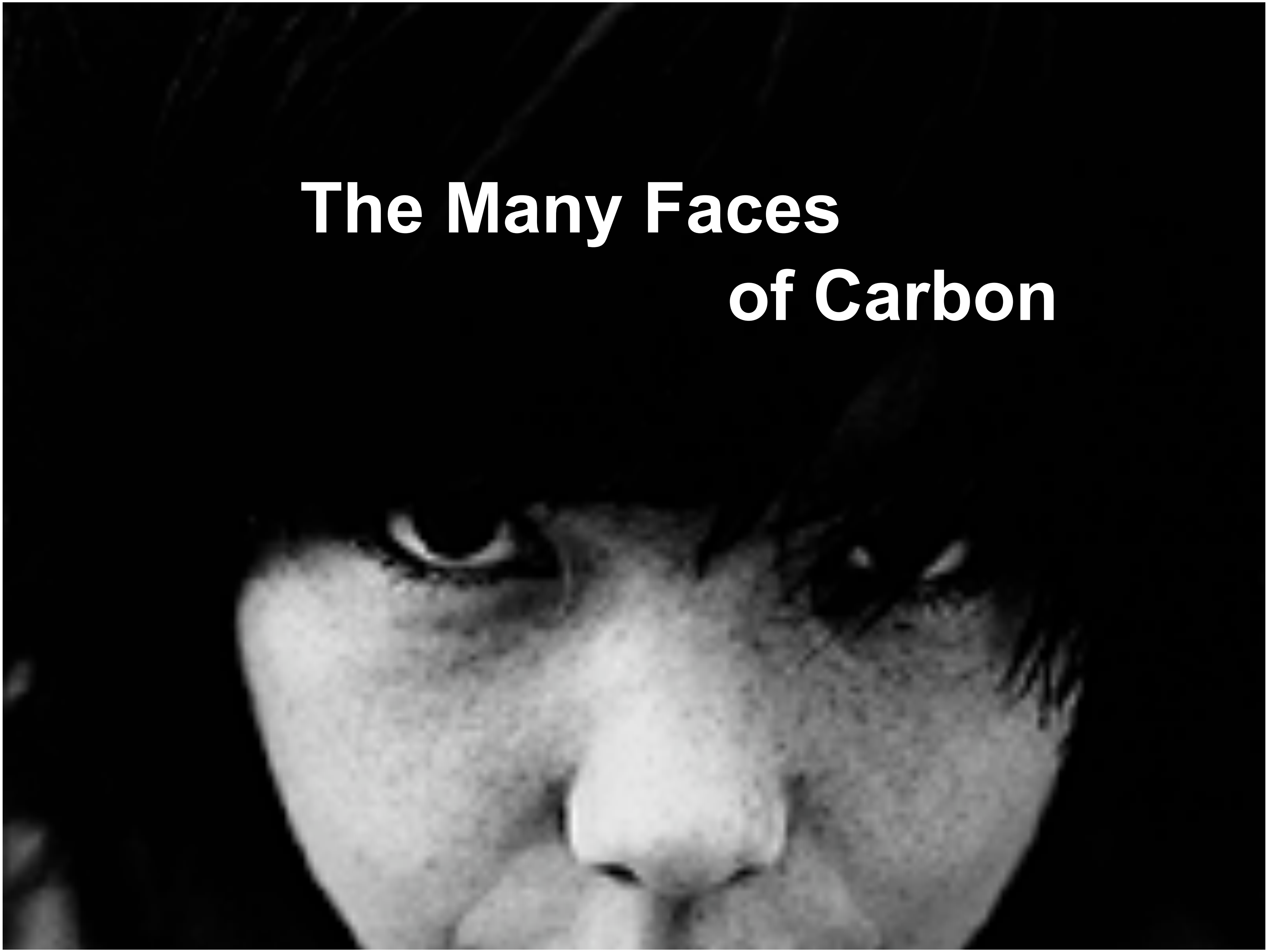
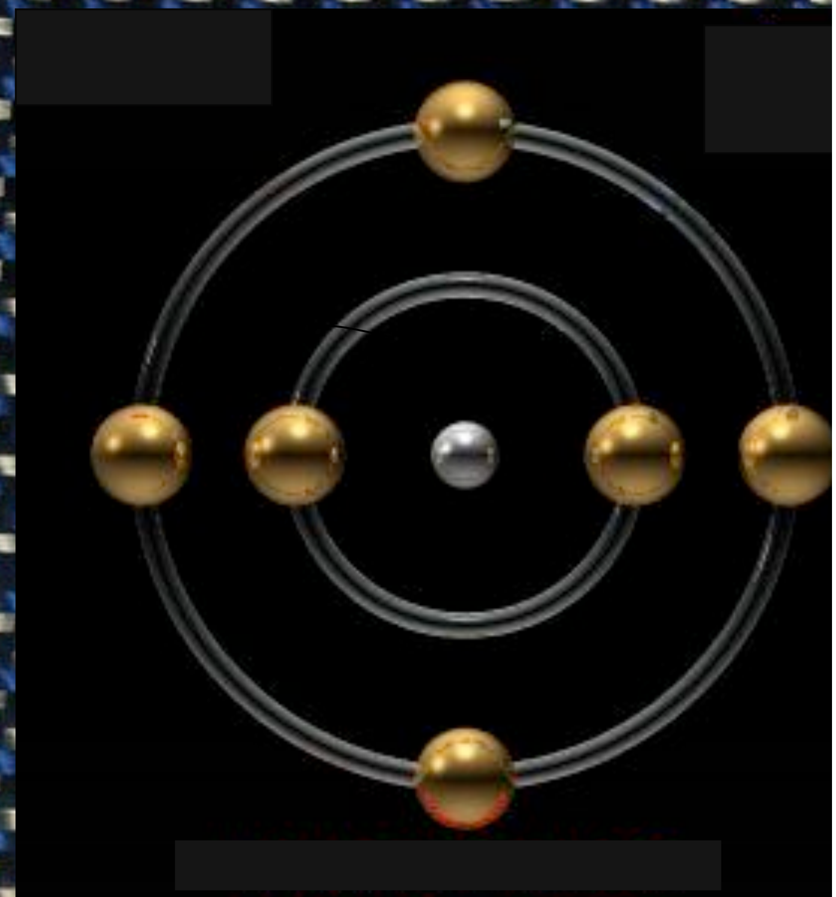
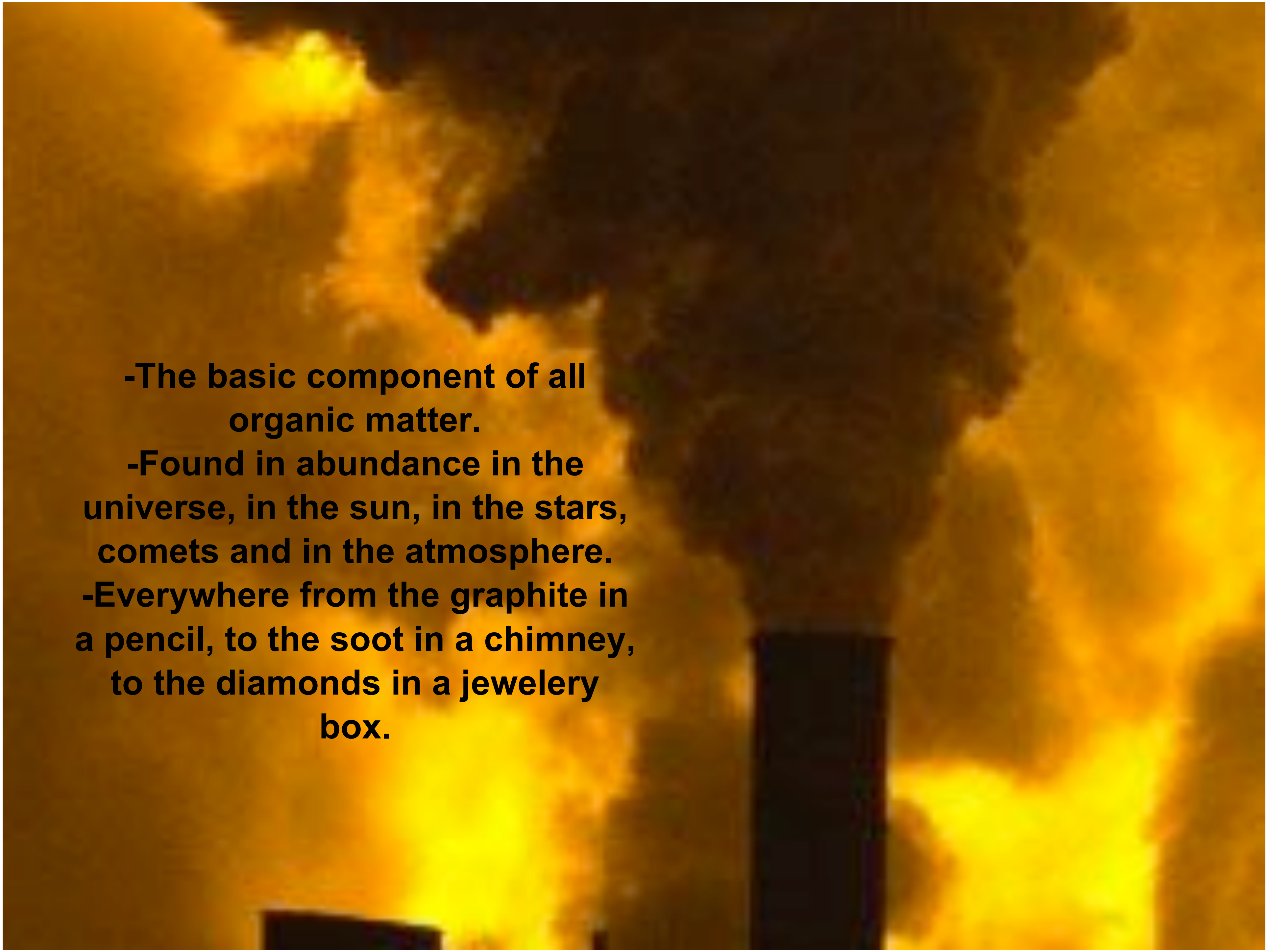

The Many Faces
of Carbon

CARBON

Symbol: C
Atomic number: 6
Atomic weight: 12




-The basic component of all organic matter.
-Found in abundance in the universe, in the sun, in the stars, comets and in the atmosphere.
-Everywhere from the graphite in a pencil, to the soot in a chimney, to the diamonds in a jewelery box.

Most carbon, is found in a form other than pure carbon, in a carbon allotrope or fullerene.

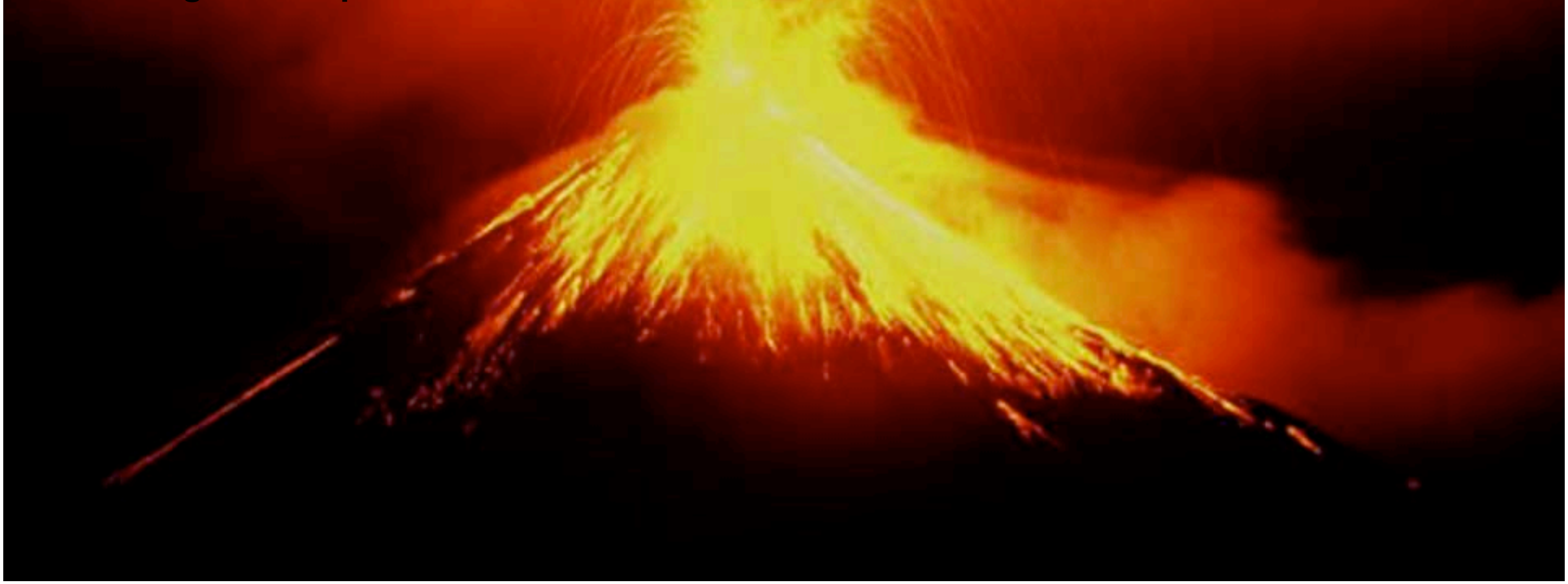
- Graphite, diamond and carbon 60 are allotropes of carbon. These allotropes are composed entirely of carbon but have different physical structures.
- A fullerene is any of the various cagelike, hollow molecules composed of hexagonal and pentagonal groups of atoms.

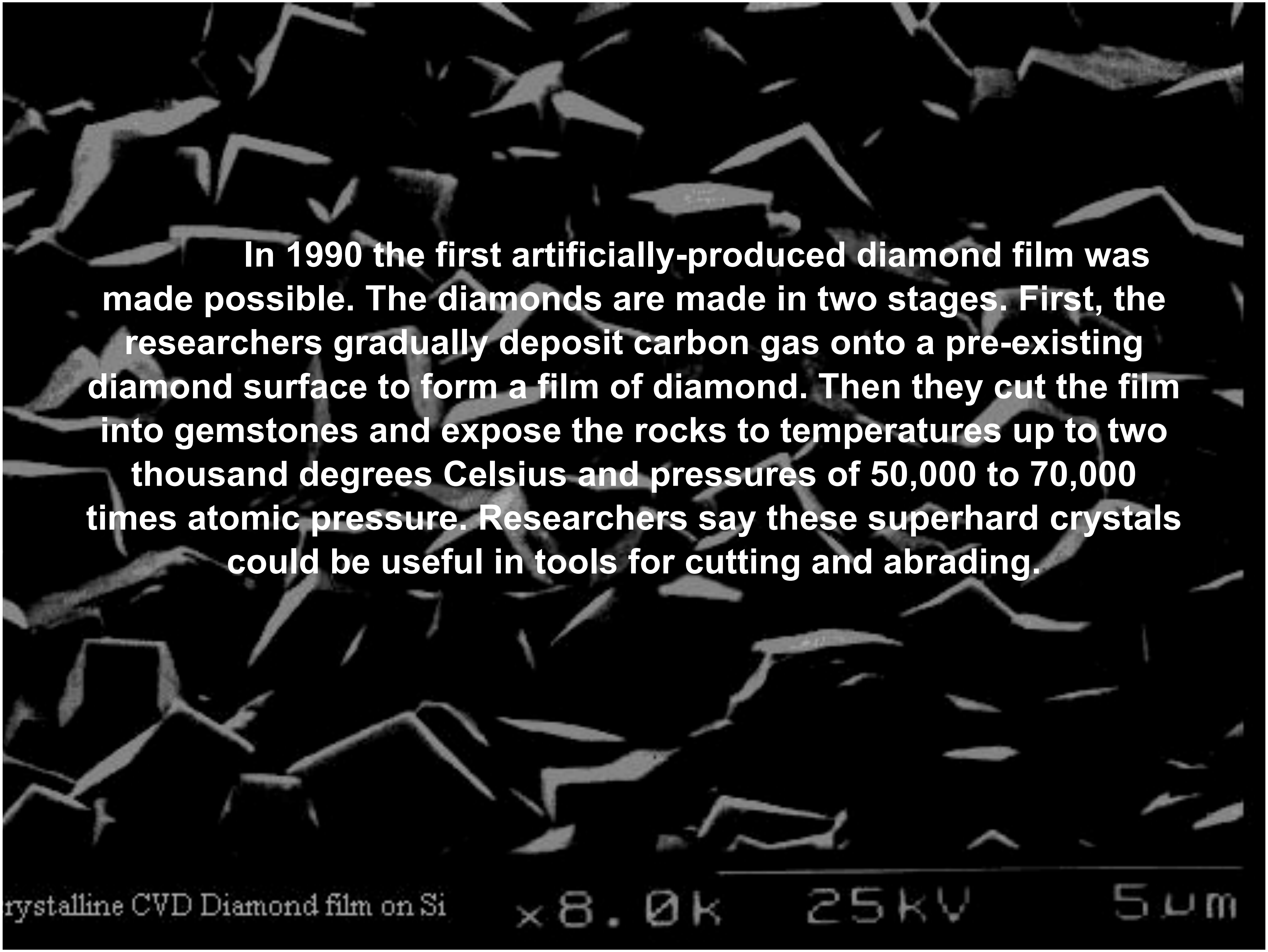
Diamond

- Hardest substance known.
- Inert to chemical corrosion.
- Can withstand compressive forces and radiation.
- Conducts heat better than any other material.
- Has extremely high electrical resistance.
- Transparent to visible light, x-rays, ultraviolet radiation, and much of the infrared spectrum.
- Highest thermal conductivity of any solid at room temperature, five times that of copper.
- Ideal optical material capable of transmitting light from the far infrared to the ultraviolet.
- High strength and rigidity, and the highest atom-number density of any material.

Natural Diamonds

- **Formed in the earth's mantle in regions of high temperature and high pressure.**
- **Volcanic eruptions that originate from such regions bring diamonds to upper portions of the earth's crust in rocks known as kibberlites..**
- **Diamonds are mined from the conduits of the volcanoes and from nearby glacial deposits in stream beds and beaches.**





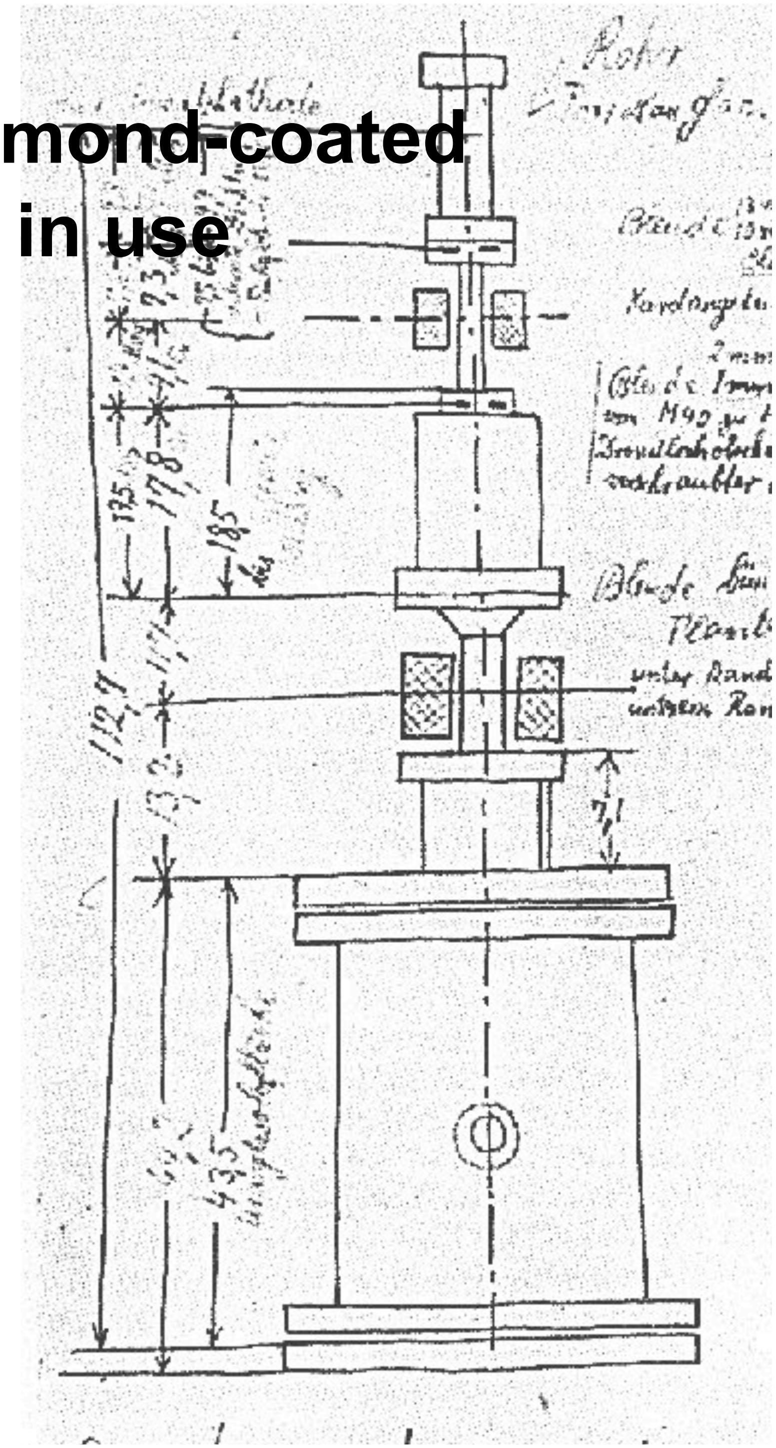
In 1990 the first artificially-produced diamond film was made possible. The diamonds are made in two stages. First, the researchers gradually deposit carbon gas onto a pre-existing diamond surface to form a film of diamond. Then they cut the film into gemstones and expose the rocks to temperatures up to two thousand degrees Celsius and pressures of 50,000 to 70,000 times atomic pressure. Researchers say these superhard crystals could be useful in tools for cutting and abrading.

Chemical Vapor Depositioning

- Another technique for producing artificial diamonds
- In the developing stages
- Low-pressure technique, hot carbon-containing gases condense and react on a hard surface to form a thin coating of diamond.
- Would allow for artificially-produced diamonds that are bigger and have less impurities and crystalline defects than those produced by the original method.
- Works one hundred times faster than the older method.
- Would also make artificially-produced diamonds affordable and accessible for certain uses in science and industry.

Diamond-based and diamond-coated products already in use

- **x-ray windows in electron microscopes**
- **strong abrasion-resistant industrial tools**
- **diaphragms for tweeters in stereo speakers**
- **diamond optical windows for spacecraft**



The Future Applications Possibilities

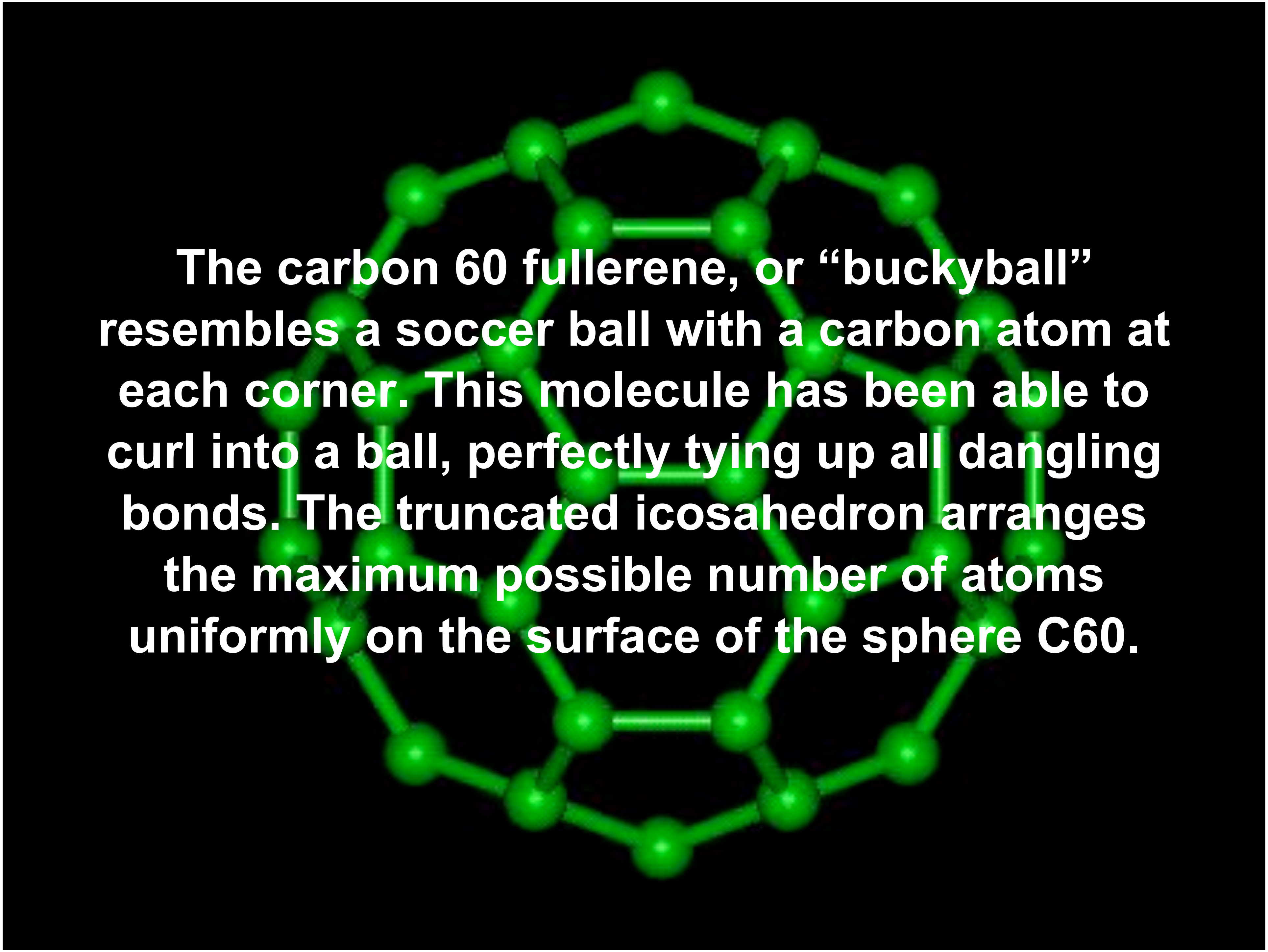
- **Diamond substrates for semiconductors**
- **Diamond's high thermal conductivity and high electrical resistivity would allow for integrated diamond circuits**
- **polycrystalline diamond films on abrasion-resistant tools.**

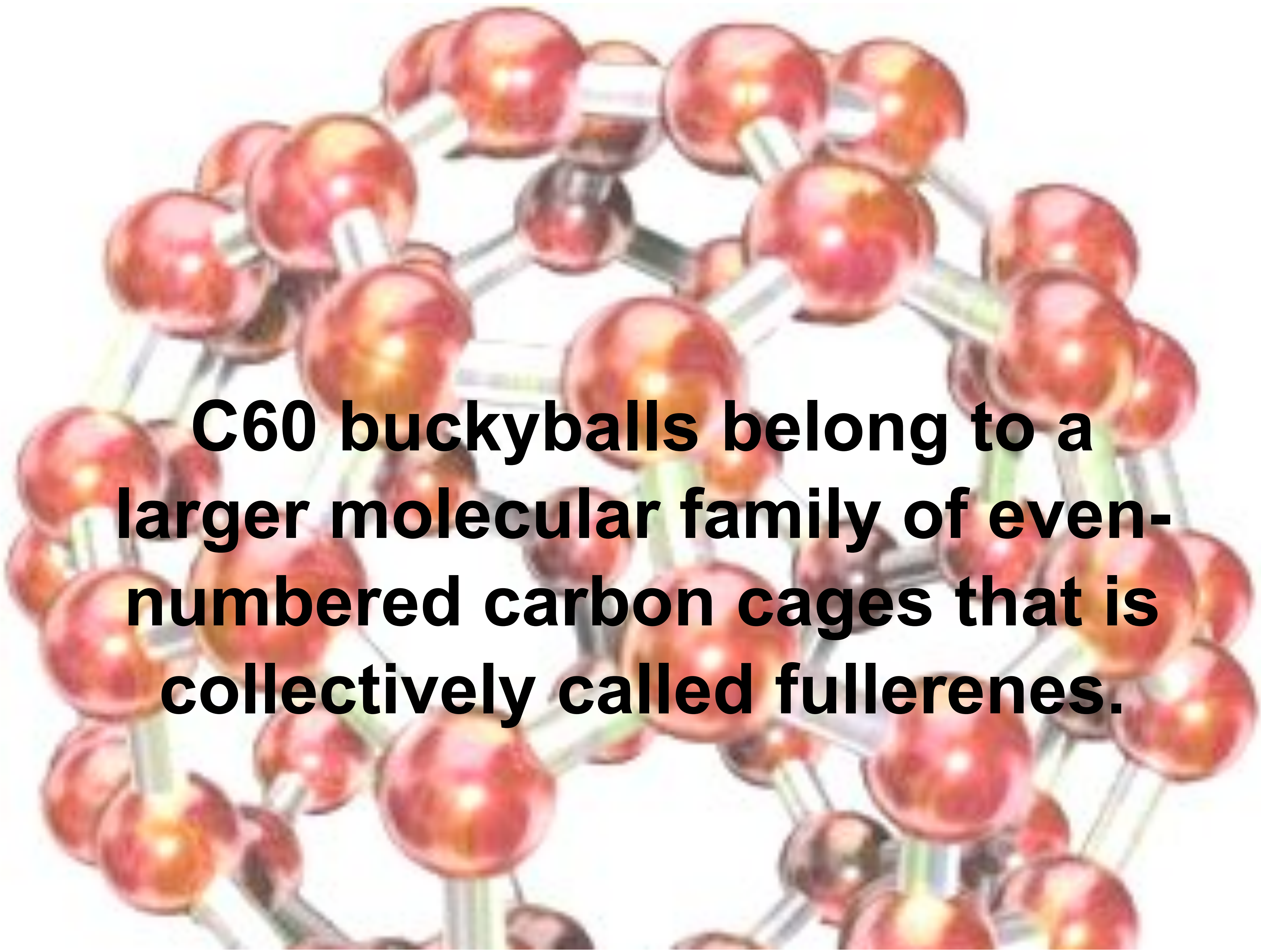
Graphite Properties

- **extremely strong fibers**
- **composed of series of stacked parallel layer sheets**
- **black and lustrous, optically opaque**
- **unaffected by weathering**
- **a pronounced softness graded lower than talc**

Graphite Applications

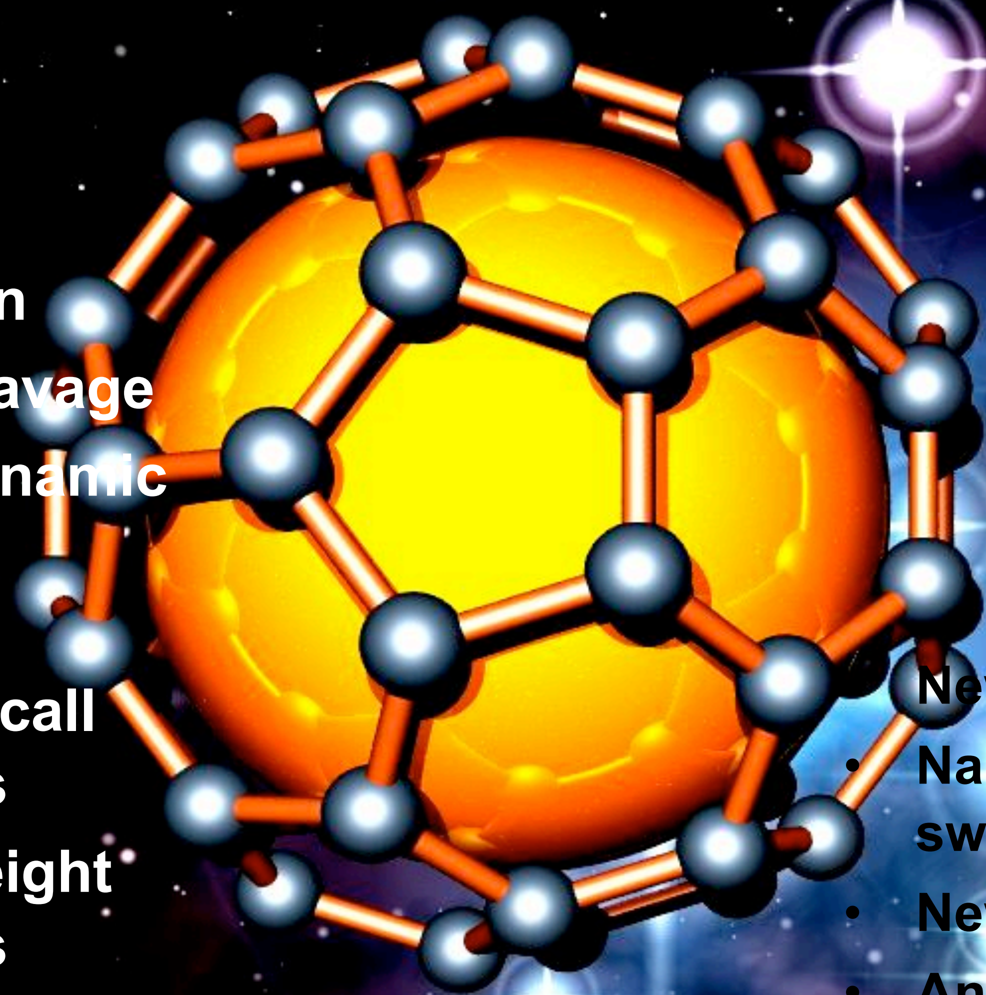
- resistant properties allow for applications in lubricating oils and greases
- dry-film lubricants
- Batteries
- conductive coatings
- electrical brushes
- carbon additives
- paints.


The carbon 60 fullerene, or “buckyball” resembles a soccer ball with a carbon atom at each corner. This molecule has been able to curl into a ball, perfectly tying up all dangling bonds. The truncated icosahedron arranges the maximum possible number of atoms uniformly on the surface of the sphere C60.



C60 buckyballs belong to a larger molecular family of even-numbered carbon cages that is collectively called fullerenes.

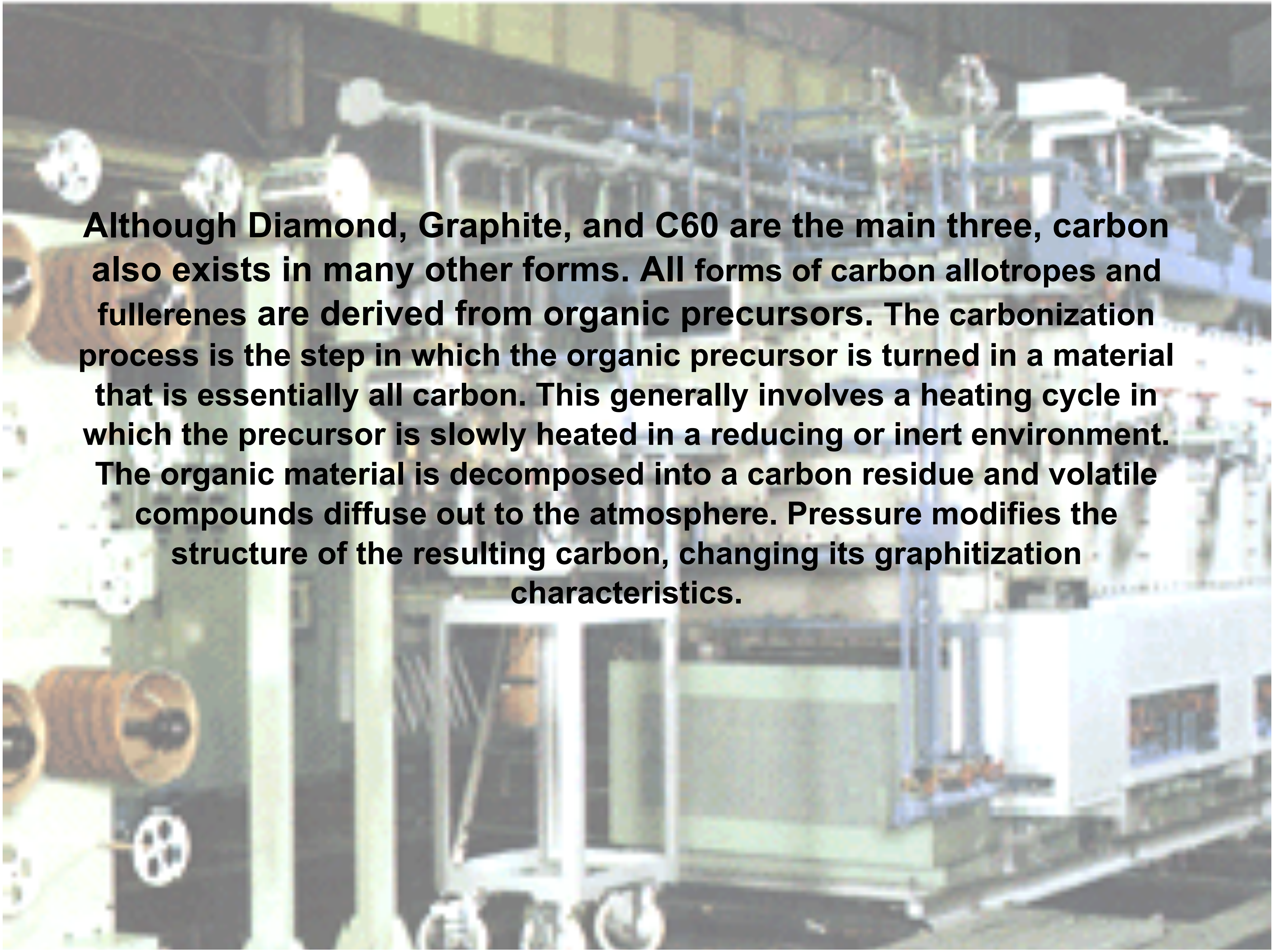
Possible Future Applications



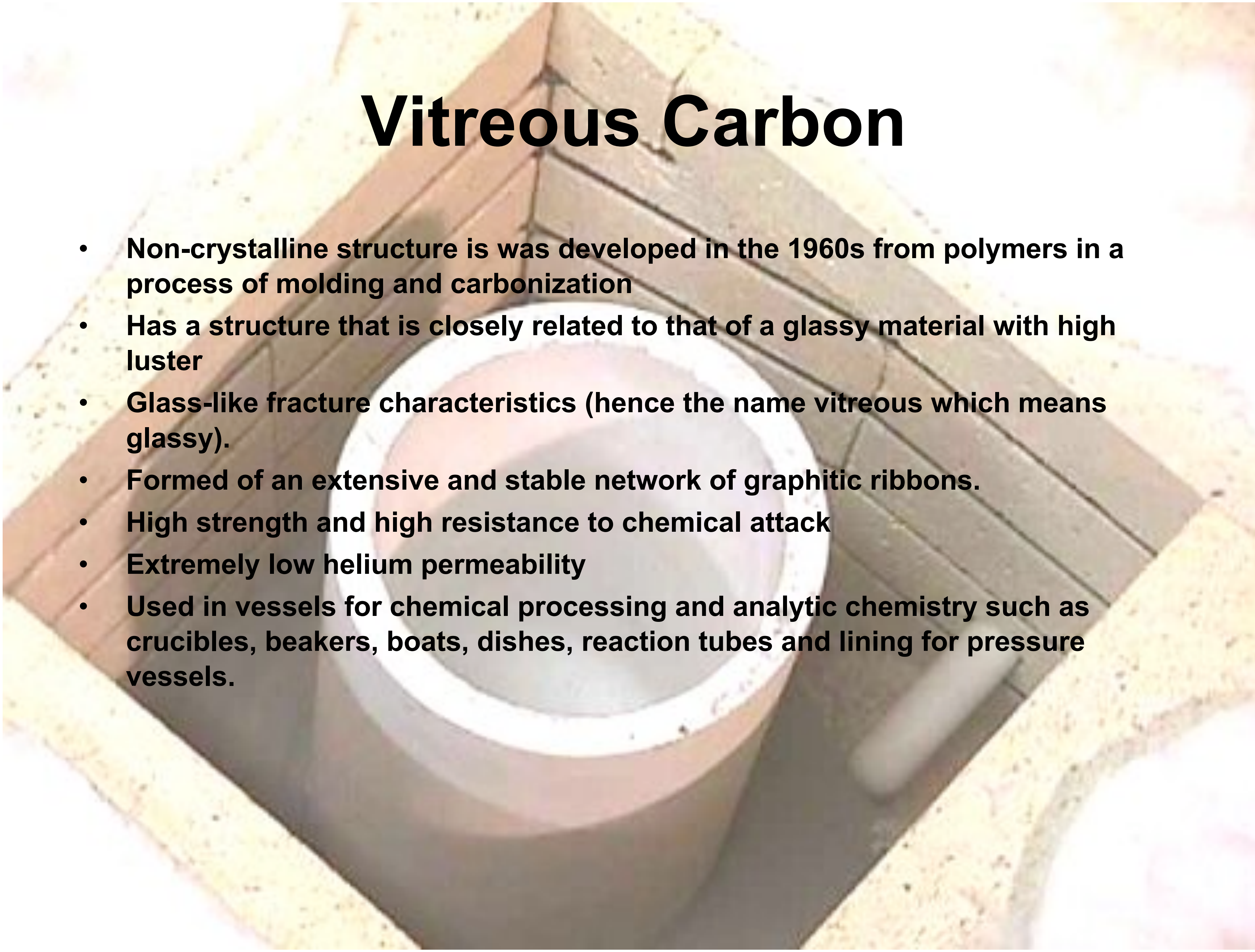
- Antiviral activity
- Enzyme inhibition
- DNA cleavage
- Photodynamic therapy
- Electron transfer call bearings
- Light-weight batteries

- New lubricants
- Nanoscale electrical switches
- New plastics
- Antitumor therapy for cancer patients

http://www.chemsoc.org/exemplarchem/entries/2003/bris



Although Diamond, Graphite, and C60 are the main three, carbon also exists in many other forms. All forms of carbon allotropes and fullerenes are derived from organic precursors. The carbonization process is the step in which the organic precursor is turned in a material that is essentially all carbon. This generally involves a heating cycle in which the precursor is slowly heated in a reducing or inert environment. The organic material is decomposed into a carbon residue and volatile compounds diffuse out to the atmosphere. Pressure modifies the structure of the resulting carbon, changing its graphitization characteristics.



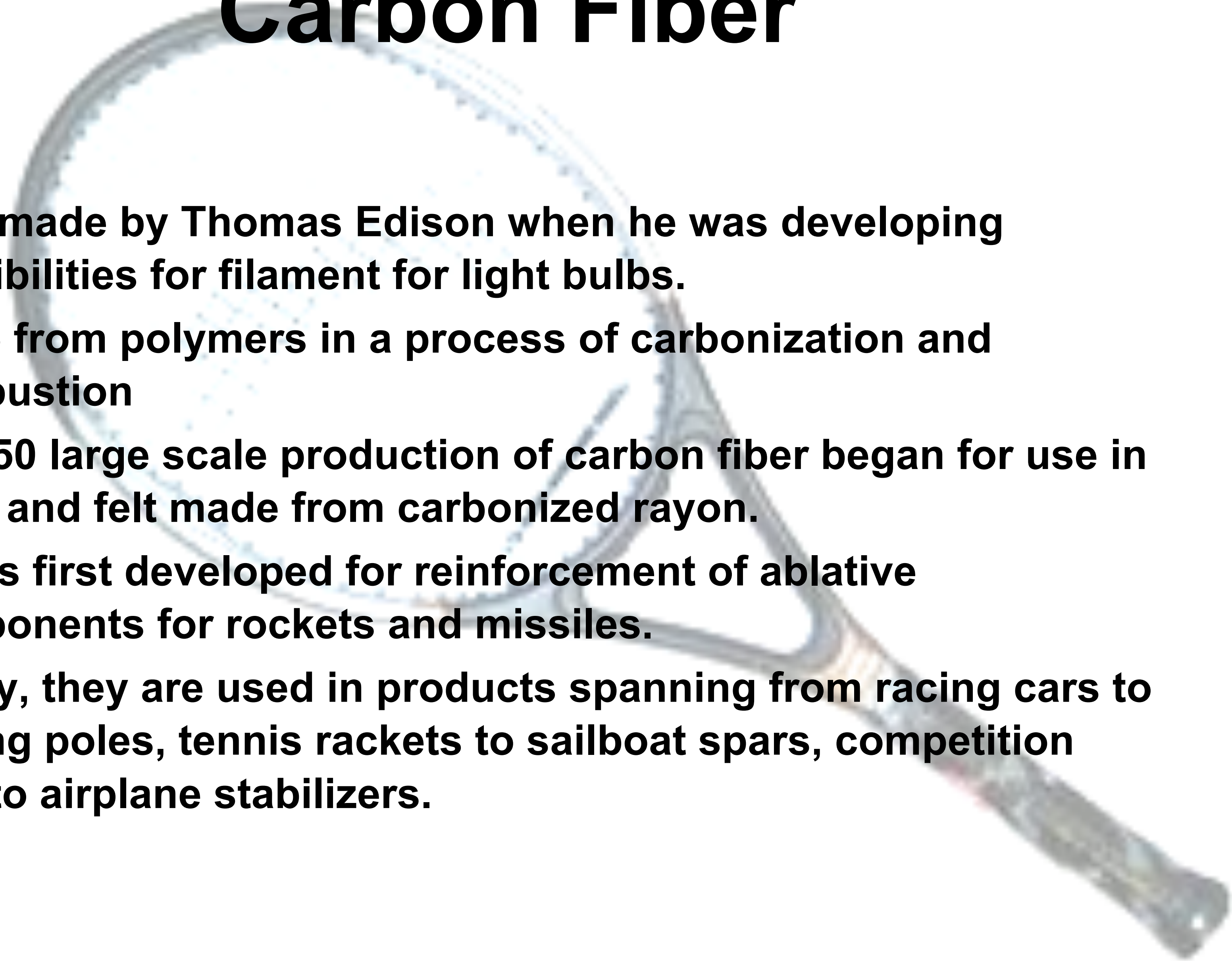
Vitreous Carbon

- Non-crystalline structure is was developed in the 1960s from polymers in a process of molding and carbonization
- Has a structure that is closely related to that of a glassy material with high luster
- Glass-like fracture characteristics (hence the name vitreous which means glassy).
- Formed of an extensive and stable network of graphitic ribbons.
- High strength and high resistance to chemical attack
- Extremely low helium permeability
- Used in vessels for chemical processing and analytic chemistry such as crucibles, beakers, boats, dishes, reaction tubes and lining for pressure vessels.

Molded Graphite

- Synthetic graphitic product made from petroleum coke and coal-tar
- Manufactured by a compaction process from a mixture of carbon filler and organic binder which is carbonized and graphitized.
- Original applications included electrodes for electric-arc furnaces and movie projectors.
- Now found in almost every corner of the industrial world and forms the base of the traditional graphite industry.

Carbon Fiber



- First made by Thomas Edison when he was developing possibilities for filament for light bulbs.
- Made from polymers in a process of carbonization and combustion
- In 1950 large scale production of carbon fiber began for use in cloth and felt made from carbonized rayon.
- Fibers first developed for reinforcement of ablative components for rockets and missiles.
- Today, they are used in products spanning from racing cars to fishing poles, tennis rackets to sailboat spars, competition skis to airplane stabilizers.

Pyrolytic Graphite

- Produced in a chemical vapor deposition process.
- Developed in the 1880's to improve the strength of filaments
- It is the only graphitic material that can be produced effectively as a coating.
- Since an increase in production after World War II, was produced in bulk form mainly for use in coatings
- extensive use in the coating of specialty molded prahites
- Because of its non-reactive nature, also used as the material for the coating of nuclear fission particles to contain the fission products as well as in heart valves and dental implants.

Carbon Nanotubes

- Spin-off product of fullerene research
- Discovered in 1991 by S. Iijima
- Consist of graphitic layers wrapped into cylinders.
- Only a few nano-meters in diameter and up to a milli meter long
- The length-to-width aspect ratio is extremely high.
- The physical properties are still being discovered and disputed.
- Have a very broad range of electonic, thermal, and structural properties that change depending on the different kinds of nanotube (defined by its diameter, length, and chirality, or twist).

CARBON 14

-The radioactive decay allows for a reliable way of dating materials that are up to 30,000 years old.

-Used for things such as to date wood from tombs or to determine the age of dead-sea scrolls and of prehistoric animals and plants.

-Has also been used in the dating of trees caught in the glaciers allowing for the mapping of glacial cycles.

Other Forms of Carbon

- Diamond-like carbon
- Activated charcoal
- carbon-carbon composites
- Coal
- Charcoal
- Hydrocarbons
- gaseous hydrocarbons
- lampblack
- carbon black.

- In short, there are many, many forms of carbon!