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Diamonds: For Ever or For Everyone?

Synthetic diamonds are making their way into the diamond industry

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In 1948, De Beers launched an advertising campaign headed by the slogan "A diamond is forever," convincing the American public that diamonds are synonymous with romance, glamour, and prestige. Since then, diamonds have been desirable as symbols of social and economic success. The expensive price tag, associated with top quality stones, however, has also prompted a search for an inexpensive way to create diamonds in the laboratory. Diamonds have been synthesized since the 1950s, but it is only recently that synthetic diamond quality has begun to be competitive with natural diamonds. Though the market is still small, synthetic diamond companies such as Apollo Diamond are bringing forth the motto, "Diamonds are for everyone," suggesting that high quality diamonds can also be affordable. Although arriving later than other synthetic gemstones, synthetic diamonds are finally making their appearance in the diamond industry.

Carbon to Diamond

In its most basic form, a diamond is simply a piece of pure carbon. Only the arrangement of the carbon atoms differentiates diamond from graphite, the more stable form of carbon at room temperature. Unlike "diamond simulants" such as cubic zirconia or mossinite, synthetic diamonds share the same crystal structure and chemical composition as natural diamonds but are not mined from the ground. Instead, companies can grow synthetic diamonds in the laboratory using either the high temperature and pressure (HPHT) method, or the chemical vapor deposition (CVD) method. The HPHT process mimics the way diamonds grow in nature by applying high temperatures and pressures to graphite. The technique involves dissolving the graphite into individual carbon atoms using a liquid metal catalyst, usually nickel or cobalt (Sergio 2002). The dissolved carbon atoms can then move through liquid to a "diamond seed crystal" and re-bond into the diamond lattice structure. The main disadvantages of HPHT are the high equipment and energy costs needed to obtain sufficient temperatures and pressures.

An alternate method of producing synthetic diamonds is chemical vapor deposition, which avoids the problems of HPHT by using a low pressure environment. The source of carbon is a hydrocarbon gas, usually methane, which dissociates into hydrogen and carbon atoms with the addition of heat from a microwave generator. The carbon atoms from the gas can attach themselves, one at a time, to a diamond seed crystal, forming a thin film that grows thicker with time. The time required to grow a diamond typically ranges from a few days to a few months (Barnard 2000).

Buying Options

Compared to the 120 million carats of natural diamonds that are mined each year, the annual production of synthetic diamond gemstones is small, only amounting to a few thousand carats (O'Donoghue 2006). While the market for lab-created diamonds is still new, companies are striving to make their synthetic diamonds more accessible to the public. In April 1995, synthetic diamond jewelry became available for public purchase at select retail stores (Cuellar 2005). In 2007, Apollo Diamond, a company based in Massachusetts, opened a web store for its CVD produced diamonds (Apollo Diamond). Using the website, customers can place orders for custom rings and shop for ready-made earrings and necklaces created with synthetic diamonds. The move towards online selling is a large step in increasing the availability of created diamonds.

One of the main incentives to buy a synthetic diamond is that it can cost less than a natural diamond. Gemesis, a Florida-based company, grows synthetic diamonds using the HPHT method and states that their lab-grown colored diamonds are on average one third the price of a comparable natural stone and that their colorless diamonds are usually less expensive than their natural counterparts (Gemesis). Synthetic diamonds represent a more inexpensive alternative for consumers and are available in a variety of different colors. Chatham Created Gems, in San Francisco, offers synthetic diamonds in 11 shades of yellow, pink, and blue (Chatham). Colored diamonds are rare in nature and therefore costly, which make synthetic colored diamonds an especially good value. Unlike in nature, creating colored diamonds is easy in the laboratory since the trace elements and crystal defects that give diamonds their color can be easily introduced during diamond growth processes. In the lab, a colorless diamond is more difficult to produce, since trace elements can unintentionally become incorporated in a diamond during the production process.

Synthetic, or man-made, diamonds share the same crystal structure and chemical composition as natural diamonds

Synthetic vs. Natural

With the unaided eye, distinguishing between a synthetic diamond and a natural diamond is virtually impossible. Examination under a microscope, however, may reveal different growth patterns or other clues to a diamond's origin. A telltale sign is the composition of inclusions, which are small amounts of a foreign material that become trapped in the diamond during growth. Natural diamonds usually have inclusions made of other natural materials, while synthetic diamonds have magnetic inclusions from substances used during synthesis (Shigley 2005). If no inclusions are present, the stone in question can also be subjected to various types of radiation, since synthetic and natural diamonds fluoresce at different wavelengths of radiation. Although identification is possible, a diamond's origin may not be immediately apparent without the correct equipment. To simplify identification, synthetic diamond companies typically laser inscribe their diamonds with a serial number.

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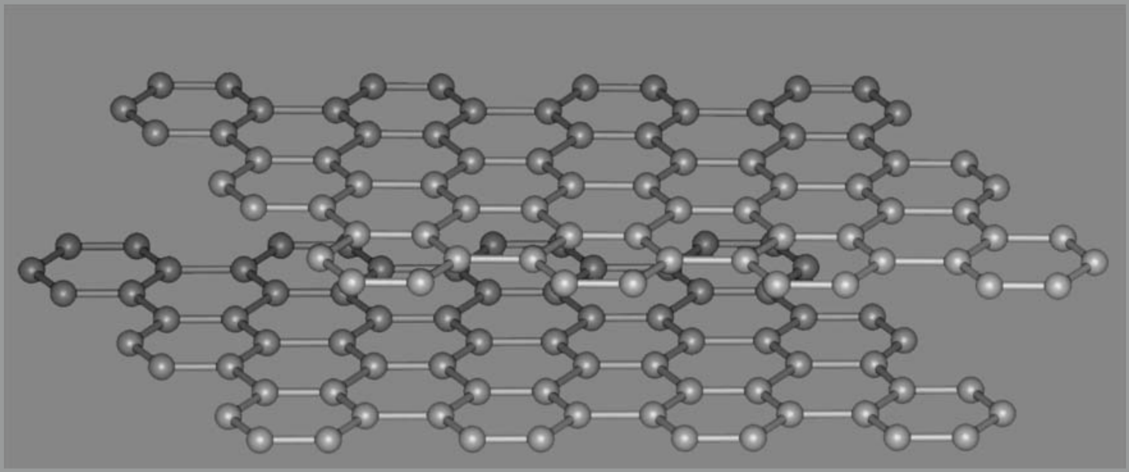
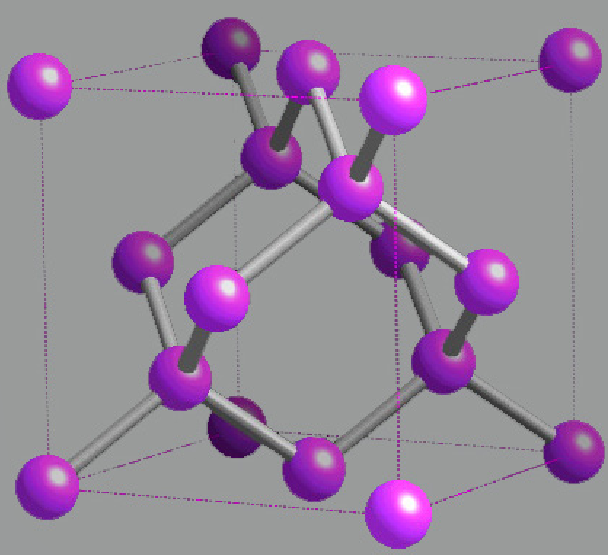


Outside the Diamond Jewelry Industry

Besides jewelry uses, diamonds have unique properties that make them valuable in other applications. For example, diamond is the hardest known substance and is useful as an abrasive for drilling, sawing, and grinding (Spear and Dismukes 1994). The optical properties of diamond enable it to serve as a scratch-resistant window coating. Diamonds can also function as capacitors by storing large amounts of energy (Chen, Changle and Chen 2008), and can be used as heat sinks and in high temperature electronics (Spear and Dismukes 1994). The numerous uses of diamond suggest that improvements in diamond synthesis technologies may have far reaching implications outside of the diamond jewelry industry.

A Diamond-Filled Future

There was once a time when the idea of creating synthetic diamonds from carbon containing materials seemed akin to turning lead into gold. While the latter process has proved to be no more than an alchemist's dream, making synthetic diamonds has become a reality in the past 50 years. Compared to the industrial, grit-sized diamonds created in the 1950s, the diamonds produced today are larger, clearer, and nearly flawless. Technology is blurring the boundaries between natural and synthetic stones, and cheap production costs in the future may lead diamond to be more freely used in other applications. Soon, synthetic diamonds may not only be for everyone, but also might begin to appear everywhere



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Arrangement of carbon attoms in graphite (above) and diamond (left).

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