Diamonds

Diamond, the hardest substance known and the only gem stone composed of a single element, is made of crystallized carbon. Ironically, graphite—another allotrope of pure carbon—is one of the softest solid minerals.

Diamond has the highest value, 10, on the Mohs scale of comparative mineral hardness. Because the Mohs scale is nonlinear, diamond is actually more than four times harder than corundum, which has a value of 9 on the scale. Diamonds have an exceptionally high optical index of refraction and a high dispersion, which gives diamonds their sparkle and "fire." Diamonds are important not only for their gem qualities, but also for their industrial uses.

The first known discoveries of diamond occurred in India. The rough stones remained uncut except for rare instances when lapidaries shaped a crystal according to whim or ground a surface flat.

Because of their beauty and hardness, diamonds were imagined to have magical powers, such as the ability to impart invulnerability to their owners, to protect a warrior in battle, to ward off the effects of poison, or to prevent mental illness.

The Greeks used the name *adamas* ("the invincible") for certain hard metals and stones. In A.D. 16 Manilius used the name *adamas* to refer to diamond, and in A.D. 100 Pliny the Younger referred to *adamas* as "the most valuable of stones, known only to kings." Roman authors later spoke of certain rivers in India yielding *adamas* among their sands. The word became garbled into adamant, diamant, and finally diamond.

The oldest specific diamond known is the Koh-i-noor, or "Mountain of Light." This gem's history extends back to 1304, when the Sultan Ala-ed-din took it from the Rajah of Maleva, whose family had held it for many generations. After a succession of owners over the centuries, the Koh-i-noor was purchased by the British in 1849. At the time, it weighed 186 carats but was crudely cut. Queen Victoria ordered that it be recut. The current version weighs about 108 carats and resides in the Queen Mother's crown.

In medieval times diamonds were valued below several other gem materials—including rubies, emeralds, and pearls—mostly because diamonds were found only in India and were not widely available. Also, lapidaries did not know how to cut diamonds to enhance their beauty.

At the end of the 17th century, however, Vincenzo Peruzzi in Italy developed the circular gem shape called the "brilliant cut," which revealed the true beauty and sparkle of diamonds. Other subsequently developed cuts—such as the marquise, oval, pear, and emerald cuts—also enhance the beauty of diamonds.

Not long after the brilliant cut was developed, which suddenly increased the desirability of these gems, diamonds were discovered in great abundance in Brazil in 1727. Brazil led world diamond production for the next 150 years.

In 1867 the children of a Boer farmer in South Africa found a 22-carat diamond. Once cut, it became the 10.73-carat "Eureka diamond." Two years later, a shepherd boy found an even larger diamond (83.5 carats) in the same area; this stone was cut into the 47.75-carat "Star of South Africa." These discoveries launched a diamond rush across South Africa, and by the following year 10,000 people were using primitive hand methods to recover diamonds from the river gravels.

The first attempt to create synthetic diamond was made in 1880 by J. Ballantine Hannay, a chemist in Scotland. Hannay used a mixture of paraffin, bone oil, and lithicum sealed in wrought-iron tubes that were heated to red hot. In three of his tests, Hannay found minute crystals which he submitted to the British Museum of Natural History as specimens of synthetic diamond. Much later, in 1943, x-ray analysis proved that they were indeed synthetic diamonds.

In 1893 another inventor, Henri Moissan, placed pure carbon and iron into a crucible which he heated in an electric furnace. He subjected the very hot mixture to sudden cooling, creating extreme pressure. Despite Moissan's claims, however, it is not generally believed that he succeeded in synthesizing diamond.

On February 16, 1955, scientists at the General Electric Company—Francis Bundy, Tracy Hall, Herbert M. Strong, and Robert H. Wentorf—announced that they had successfully synthesized industrial diamonds. They followed basic research conducted by Percy W. Bridgman of Harvard University, who showed that at sufficiently high temperatures and pressures, diamond rather than graphite is the stable form of carbon. Bridgman subjected graphite to pressures in excess of 40 GPa, but did not succeed in converting graphite to diamond.

The General Electric team placed graphite into huge hydraulic presses, using temperatures above 5000°F (2760°C) and a simultaneous pressure of 12 GPa to produce small industrial-grade diamonds. Starting in 1960, their techniques were used to produce commercial quantities of industrial diamonds. Given sufficient temperature and pressure, any convenient form of carbon can be used as a raw material. (According to a brief listing in the *Encyclopedia Americana*, even the carbon in peanut butter has been used!) DuPont introduced a method for creating synthetic diamond powder in 1968, placing carbon under a blanket of high-velocity plastic explosive.

Strong and Wentorf synthesized gem-quality diamonds in 1970 by dissolving synthetic diamond powder in a bath of molten metal under high pressure and temperature. Carbon atoms from the dissolved powder migrated to one end of the bath that contained tiny seed crystals. The carbon atoms settled and crystallized on the seed crystals, which grew into diamonds weighing a carat or more.

The color of diamond varies from colorless to black, ranging from transparent to opaque. The diamonds preferred as gems are colorless and transparent, though most gem diamonds are tinged with yellow. Red, blue, and green diamonds are rarest, while orange, violet, and yellow stones are more common. The color of diamond can be changed by exposure to radiation. When exposed to radium, a diamond can change color to green. When bombarded in a cyclotron with alpha, neutron, or deuteron particles, its color can shift to green, blue, yellow-green, or black. Such treatment, though, changes the color only on a thin external layer and also imparts residual radioactivity, making the gem unwearable as jewelry.

Apart from their use as gems, diamonds are also used in industry to cut metals and to tip bits from dental drills to rock-coring drills in mining and oil-well drilling. Crushed diamond powder is used in many grinding, polishing, and sawing applications. In more recent times, chemical vapor deposition has been used with great success to create diamond and diamond-like films.

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FOR FURTHER READING: Lawrence L. Copeland, *Diamonds* (Los Angeles, 1966) and Joan Younger Dickinson, *The Book of Diamonds* (New York, 1965).

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