Diamond and graphite

Environment, Nature

" In mineralogy, diamond (from the ancient Greek ?????? – adamas " unbreakable") is an allotrope of carbon, where the carbon atoms are arranged in a variation of the face-centered cubic crystal structure called a diamond lattice. Diamond is renowned as a material with superlative physical qualities, most of which originate from the strong covalent bonding between its atoms. In particular, diamond has the highest hardness and thermal conductivity of any bulk material. ELECTRICAL CONDUCTANCE: - Diamond is less stable than graphite, but the conversion rate from diamond to graphite is negligible at ambient conditions. Other specialized applications also exist or are being developed, including use as semiconductors: some blue diamonds are natural semiconductors, in contrast to most diamonds, which are excellent electrical insulators. The conductivity and blue color originate from boron impurity.

Boron substitutes for carbon atoms in the diamond lattice, donating a hole into the valence band. Substantial conductivity is commonly observed in nominally undoped diamond grown by chemical vapor deposition. This conductivity is associated with hydrogen-related species adsorbed at the surface, and it can be removed by annealing or other surface treatment HARDNESS: - Diamond is the hardest natural material known, where hardness is defined as resistance to scratching and is graded between 1 (softest) and 10 (hardest) using the Mohs scale of mineral hardness. Diamond has a hardness of 10 (hardest) on this scale. Diamond's hardness has been known since antiquity, and is the source of its name. Diamond hardness depends on its purity, crystalline perfection and orientation: hardness is higher for flawless, pure crystals oriented to the direction (along the longest diagonal of the cubic diamond lattice). Therefore, whereas it might be possible to scratch some diamonds with other materials, such as boron nitride, the hardest diamonds can only be scratched by other diamonds and nanocrystalline diamond aggregates.

The hardness of diamond contributes to its suitability as a gemstone. Because it can only be scratched by other diamonds, it maintains its polish extremely well. Unlike many other gems, it is well-suited to daily wear because of its resistance to scratching—the hardest natural diamonds mostly originate from the Copeton and Bingara fields located in the New England area in New South Wales, Australia. These diamonds are generally small, perfect to semiperfect octahedra, and are used to polish other diamonds. Their hardness is associated with the crystal growth form, which is single-stage crystal growth. Most other diamonds show more evidence of multiple growth stages, which produce inclusions, flaws, and defect planes in the crystal lattice, all of which affect their hardness. It is possible to treat regular diamonds under a combination of high pressure and high temperature to produce diamonds that are harder than the diamonds used in hardness gauges.

Somewhat related to hardness is another mechanical property toughness, which is a material's ability to resist breakage from forceful impact. The toughness of natural diamond has been measured as 2. MPa·m1/2, and the criticalstressintensity factor is 3. 4 MN·m? 3/2. Those values are good compared to other gemstones, but poor compared to most engineering materials. As with any material, the macroscopic geometry of a diamond contributes to its resistance to breakage. Diamond has a cleavage plane and is therefore more fragile in some orientations than others.

Diamond cutters use this attribute to cleave some stones, prior to faceting. USES: - The market for industrial-grade diamonds operates much differently from its gem-grade counterpart. Industrial diamonds are valued mostly for their hardness and heat conductivity, making many of the gemological characteristics of diamonds, such as clarity and color, irrelevant for most applications. This helps explain why 80% of mined diamonds (equal to about 135, 000, 000 carats (27, 000 kg) annually), unsuitable for use as gemstones, are destined for industrial use. In addition to mined diamonds, synthetic diamonds found industrial applications almost immediately after their invention in the 1950s; another 570, 000, 000 carats (110, 000 kg) of synthetic diamond is produced annually for industrial use. Approximately 90% of diamond grinding grit is currently of synthetic origin. The boundary between gem-quality diamonds and industrial diamonds is poorly defined and partly depends on market conditions (for example, if demand for polished diamonds is high, some suitable stones will be polished into low-quality or small gemstones rather than being sold for industrial use).

Within the category of industrial diamonds, there is a sub-category comprising the lowest-quality, mostly opaque stones, which are known as bort. Graphite is a black opaque solid with metallic shine. It is very soft and feels greasy. Greasy feeling of graphite is due to ease with which layers can slide one over the other in graphite. The mineral graphite is one of the allotropes of carbon. It was named by Abraham Gottlob Werner in 1789 from the Greek ??????? (graphein): " to draw/write", for its use in pencils, where it is commonly called lead (not to be confused with the metallic element lead). Unlike diamond (another carbon allotrope), graphite is an electrical conductor, a semimetal.

Graphite is the most stable form of carbon under standard conditions. Therefore, it is used in thermo chemistry as the standard state for defining the heat of formation of carbon compounds. Graphite may be considered the highest grade of coal, just above anthracite and alternatively called meta-anthracite, although it is not normally used as fuel because it is hard to ignite. There are three principal types of natural graphite, each occurring in different types of ore deposit: 1. Crystalline flake graphite (or flake graphite for short) occurs as isolated, flat, plate-like particles with hexagonal edges if unbroken and when broken the edges can be irregular or angular; 2. Amorphous graphite occurs as fine particles and is the result of thermal metamorphism of coal, the last stage of coalification, and is sometimes called meta-anthracite. Very fine flake graphite is sometimes called amorphous in the trade; 3.

Lump graphite (also called vein graphite) occurs in fissure veins or fractures and appears as massive platy intergrowths of fibrous or acicular crystalline aggregates, and is probably hydrothermal in origin. ELECTRICAL CONDUCTANCE: - Somewhat of a surprise is that at surface temperatures and pressures, Graphite is the stable form of carbon. In fact, all diamonds at or near the surface of the Earth are currently undergoing a transformation into Graphite. This reaction, fortunately, is extremely slow. Graphite intercalation compounds (GICs) are complex materials having formula XC y ...

the in-plane electrical conductivity generally increases. HARDNESS: - These are the most common types of pencils, and are encased in wood. They are made of a mixture of clay and graphite and their darkness varies from light grey to black. Their composition allows for the smoothest strokes. As the name implies, these are solid sticks of graphite, USES: - Natural graphite is mostly consumed for refractories, steelmaking, expanded graphite, brake linings, foundry facings and lubricant. Graphene, which occurs naturally in graphite, has unique physical properties and might be one of the strongest substances known; however, the process of separating it from graphite will require some technological development before it is economically feasible to use it in industrial processes. Graphite (carbon) fiber and carbon nanotubes are also used in carbon fiber reinforced plastics, and in heat-resistant composites such as reinforced carbon-carbon (RCC).

Products made from carbon fiber graphite composites include fishing rods, golf clubs, bicycle frames, and pool cue sticks and have been successfully employed in reinforced concrete. The mechanical properties of carbon fiber graphite-reinforced plastic composites and grey cast iron are strongly influenced by the role of graphite in these materials. In this context, the term "(100%) graphite" is often loosely used to refer to a pure mixture of carbon reinforcement and resin, while the term " composite" is used for composite materials with additional ingredients. [21] Graphite has been used in at least three radar absorbent materials. It was mixed with rubber in Sumpf and

Schornsteinfeger, which were used on U-boat snorkels to reduce their radar cross section. It was also used in tiles on early F-117 Nighthawks. Modern smokeless powder is coated in graphite to prevent the buildup of static charge.