

Carbonado Diamonds and the Application of their Unique Properties

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Abstract

To this days, carbonado diamonds remain a subject of discussion, and scientists are still studying their properties to understand what else they are capable of in their applications. Carbonado diamonds are extremely rare and occur in very limited quantities, which only increases interest in them.

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Carbonado is a special type of diamonds that stands out for its unique structure and properties. It is a polycrystalline variety of black cubic diamond. They are described as fine-grained, porous aggregates and can have a black, gray, or slightly greenish color.

Due to its structure, carbonado possesses incredible mechanical strength, making it one of the hardest materials on the planet. The bonding between crystal grains is heterogeneous, resulting in a porous structure. It contains graphite and iron compounds - hematite and magnetite, which give it a dark color. The high number of inclusions makes carbonado opaque. The mutual arrangement of diamond crystals does not reflect light but rather absorbs it, depriving it of the famous diamond sparkle or "fire". The features of the polycrystalline structure account for the extraordinary strength of carbonado, unlike ordinary diamonds, which are quite brittle. At the same time, the mineral retains its super hardness.

The name carbonado comes from the word "coal" since these diamonds externally resembled ordinary coal. The term began to be used when the crystals were first discovered in Brazil in the 18th century. Geologists estimate that black diamonds appeared on Earth approximately 2.6 to 3.5 billion years ago. They are most commonly found in the Central African Republic and Brazil.

According to researchers, during this time, the territories of modern Brazil and the Central African Republic were part of the supercontinent Gondwana. It is assumed that it was during

this time that a meteorite carrying diamonds hit our planet. Therefore, all current carbonado deposits are located in such a small area.

There is a theory that black diamonds appeared on Earth from space, for example, after the explosion of a supernova in a vacuum.

Researchers from the United States (a group of American scientists from the National Laboratory in Brookhaven led by Stephen Haggerty and Mark Chance) discovered rare titanium and nitrogen compounds in carbonado, previously found only in meteorites. In another study, laboratory employees used an infrared synchrotron and found hydrogen in carbonado, common in space. They noted that diamond dust, from which the crystals formed, could have appeared after the transformation of a supernova several billion years ago.

But there is a theory that carbonado was formed on Earth. Its supporters argue that in 1993, black diamonds were found in unusual volcanic rocks called kimberlites.

American geologist Aaron Celestian believes that carbonados appeared in the depths of the Earth and lie deeper than ordinary diamonds.

Ordinary diamonds are mined in kimberlite rock, while carbonado diamonds are found in alluvial sedimentary deposits. There are tiny diamond particles in the crystals, but there are no remnants of minerals that are formed and located deep in the mantle. This sets them apart from ordinary diamonds.

Carbonado contains hydrogen, nitrogen, and osbornite. The latter is a natural form of titanium nitride, which was found in meteorites.

Studying black diamonds will help scientists understand more about the structure of the Earth's interior and its formation, as well as the composition of celestial bodies that could have transported crystals to our planet.

If we assume the terrestrial origin of carbonado, in the crater of a volcano, where methane and hydrogen flows are always present, emanating from the depths of the planet, groups of small diamonds are formed, which, during crystallization, fuse into clumps. Titanium, nitrogen, and hydrogen in volcanic rocks are also often present.

Analyzing carbonado, scientists have assessed the prospects for the use of super diamonds in the electronics industry as a replacement for silicon.

A technology for obtaining super diamonds has been developed: chemical deposition from the gas phase at low pressure. A small diamond grain is placed in a vacuum chamber at a pressure

below atmospheric, the chamber is heated, then methane is pumped into it, followed by hydrogen. After that, microwaves are generated, causing a cloud of carbon atoms to be released, which settle on the grain. This method allows not only to grow standard crystals but also diamond plates less than a millimeter thick. Such plates conduct electricity, have unique thermal conductivity, and withstand high temperatures. They are used to create perfect microchips with a high degree of integration and resistance to overheating.

Carbonado diamonds also have high thermal conductivity, making it useful in many areas requiring efficient heat dissipation.

Thanks to its incredible strength, carbonado is used in tools for cutting and polishing other materials such as metals and stones.

Due to its high thermal conductivity, carbonado can be used in radiators for heat dissipation from electronic components such as microprocessors and other electronic devices.

The application field of such carbonado materials is extremely wide: from wear-resistant artificial joints to nanoresonators (the basis of all acoustic equipment) and super microchips.

Let's see closely:

1. **Artificial Joints:** Carbonado's remarkable strength and durability make it an ideal material for manufacturing artificial joints. Unlike traditional materials, carbonado-based joints are wear-resistant and can withstand prolonged use without degradation. This makes them particularly suitable for implants in orthopedic surgery, where long-term reliability is crucial.
2. **Nanoresonators:** Carbonado's unique structural properties make it well-suited for use in nanoresonators, which serve as the foundation of acoustic equipment. Nanoresonators are miniature devices that vibrate at specific frequencies to generate or detect sound waves. Carbonado's high mechanical strength and stability allow for precise control over the resonant frequencies, enabling the development of highly sensitive and efficient acoustic devices for various applications such as sensors, actuators, and communication systems.
3. **Super Microchips:** Carbonado's exceptional thermal conductivity and durability make it an attractive material for use in the production of super microchips. Microchips are integral components of electronic devices, responsible for processing and storing data. By incorporating carbonado into microchip manufacturing processes, engineers can

create chips that exhibit superior heat dissipation capabilities and enhanced resistance to temperature-induced damage. This enables the development of high-performance computing systems, advanced sensors, and cutting-edge electronic devices that operate reliably under demanding conditions.

4. **High-Performance Cutting Tools:** Carbonado's hardness and wear resistance make it an excellent material for manufacturing high-performance cutting tools. Tools such as drills, saw blades, and grinding wheels made from carbonado can withstand extreme temperatures and abrasive conditions encountered during machining operations. Additionally, carbonado-based cutting tools maintain their sharpness over extended periods, resulting in improved cutting efficiency and reduced tool replacement costs in industries such as aerospace, automotive, and manufacturing.
5. **Radiation Shielding:** Carbonado's dense and opaque nature makes it an effective material for radiation shielding applications. Its ability to absorb and attenuate ionizing radiation makes it invaluable in environments where protection against radiation exposure is critical, such as nuclear power plants, medical imaging facilities, and space exploration missions. By incorporating carbonado into shielding structures, engineers can enhance radiation protection measures and ensure the safety of personnel and equipment in radiation-prone environments.
6. **Advanced Composite Materials:** Carbonado can be used as a reinforcing agent in the production of advanced composite materials. By embedding carbonado particles or fibers into a matrix material such as polymer resin or metal alloy, engineers can enhance the mechanical properties and durability of the resulting composite. These carbonado-reinforced composites exhibit exceptional strength-to-weight ratios, high stiffness, and resistance to fatigue and corrosion, making them ideal for applications in aerospace, automotive, marine, and sporting goods industries.

In summary, the wide-ranging applications of carbonado materials, spanning from artificial joints to super microchips, highlight their versatility and significance in various industries. As researchers continue to explore and harness the unique properties of carbonado, it is expected to play an increasingly vital role in advancing technology and addressing complex engineering challenges in the future.