

DIAMONDS, THE TRUTH BEHIND THE BLING

(1) Diamonds are the most expensive gemstones on Earth. For many of us, having access to diamonds will require a lot of money. However, what if I told you that there might be diamonds coating a saw blade in your garage, or that there could be diamonds in your face scrub? If you have ceramic tiles in your kitchen or bathroom, they were most likely cut to shape by diamonds. Beyond jewellery making, a diamond has many practical and industrial uses due to its unique properties.



(2) Diamonds are made from pure carbon atoms, however, so is graphite, a charcoal-like substance that you would load into a mechanical pencil. How can two things that look so different be made from exactly the same atoms? The difference lies in how the carbon atoms bond to each other in each substance. In a diamond, the carbon atoms form a tetrahedral shape that is extremely strong. In graphite, the atoms form a honeycomb structure in flat planes, making graphite very brittle and easy to break. The strength of a diamond makes it useful for many practical purposes. The word diamond comes from the Greek word *adamas* meaning indestructible. A diamond is the hardest natural substance on Earth. The Mohs scale of mineral hardness measures the hardness of minerals. Diamonds have the highest rating of 10. Only a diamond can cut another diamond.

(3) Natural diamonds are formed geologically over hundreds of millions of years through the application of intense pressure and heat on deposits of carbon. When diamonds are mined, they do not resemble the diamonds you see in a diamond ring. Raw diamonds have yet to be cut and polished to create the flat surfaces, called facets, that cause light to bounce within the diamond. This internal reflection of light is what makes a diamond look sparkly and this is called a diamond's *brilliance*. A diamond's mass is expressed in carats. One carat is equal to 200mg. A one carat diamond ring starts at \$3000 and can go as high as \$27 000 depending on the quality of the diamond.

(4) If diamonds are this expensive, how can we afford to have them in beauty products and on coatings for saw blades and drill bits? In the 1950s, several commercial processes for

creating synthetic diamonds were developed. These allowed scientists to make synthetic diamonds very cheaply. Depending on the quality of the manufacturing, these synthetic diamonds can have certain properties, like hardness and conductivity, that are superior to the best quality natural diamonds. When it comes to beauty, however, many synthetic diamonds are made for industrial purposes so the focus isn't on size, clarity or colorlessness, all of which are valued in natural diamonds.

(5) One common technique for synthetic diamond manufacturing is called the HPHT method, or high-pressure high-temperature method. This method simulates the hundreds of millions of years of geological heat and pressure that is needed to create natural diamonds. In the CPV, or chemical vapor deposition method, methane gas (CH_4) is used as a carbon source and it is combined in a chamber with hydrogen gas. Both gases are then highly energized causing the separation of the carbon from the methane. The carbon can then solidify into a diamond crystalline structure on top of a prepared substrate. This method allows many different types of diamond coated materials to be manufactured in all shapes and sizes. CPV also allows the diamond to form a flat sheet that covers a large area, which is something the HPHT method can't do. A third, but less popular method, is called detonation synthesis. In this process, carbon is literally blown up to create the forces needed to produce diamonds. The diamonds synthesized using this method are extremely small diamond grains on the nanometer scale.

(6) What are these synthetic diamonds used for? Some are sold as diamonds for jewellery,

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but the majority are used for less glamorous purposes. Diamond grains are used as abrasive coatings on devices that are supposed to cut into hard or delicate materials. Oil and natural gas drilling rigs use huge drill bits that are coated in diamonds. This makes it easier to cut through kilometers of dense earth and rock. Diamond scalpels have also been made for surgery for use on fragile eye and brain tissue. Super strong diamond window panes have been put on spaceships to withstand the extremes of space travel. Besides being amazingly hard, diamonds are also the best thermal conductors in the world. Diamonds can easily draw heat away from where it is being generated, making them great heat sinks for removing excess heat

from highly heat sensitive microelectronic and telecommunications devices.

(7) What if the Earth's crust was made of diamonds? There would be no need to make synthetic diamonds. This may seem ridiculous to you, but in 2004 a planet was discovered that seems to be made of at least one third diamonds. *55 Cancri e* is a planet that orbits a star in our Milky Way galaxy. Based on analysis of its mass, radius and composition, *55 Cancri e* is estimated to be composed mostly of carbon and much of it is of the diamond variety. Having a planetary surface temperature of more than 3000°F/1649°C does a lot to help transform carbon into diamonds.

Article Questions

- 1) The word diamond comes from the Greek word _____ which means _____. A diamond's sparkle is called its _____. A _____ is equivalent to 200mg of diamond. Diamond coated structures can be synthesized using the _____ (provide full name) method.
- 2) What makes diamonds so strong and graphite so brittle and breakable?
- 3) How are natural diamonds formed?
- 4) What does HPHT stand for and what does it attempt to do?
- 5) Identify two unique properties of diamonds. Explain how each property makes diamonds useful for a commercial application.
- 6) Planet *55 Cancri e* has two primary factors that make the formation of diamonds highly likely. What are these two factors?