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ИННОВАЦИИ В ТРАНСПОРТНОМ СТРОИТЕЛЬСТВЕ

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DIAMOND AND ITS APPLICATION IN ENGINEERING

Abstract. The article written about the use of diamonds in engineering and in technology. At the beginning of the article, a general description of the diamond and its physical and chemical properties is given. In the current time using artificial diamonds is a big problem.

Аннотация. В статье написано об использовании алмазов в технике и в инженерии. В начале статьи дается общее описание алмаза и его физические и химические свойства. В нынешнее время использование искусственных алмазов является большой проблемой.

Аңдатпа. Мақалада алмаздың техникада және инженерияда қолданылуы жайлы мәліметтер көрсетілген. Мақала басында алмазға жалпы сипаттама берілген және физикалық, химиялық құрамына тоқталып өткен. Қазіргі таңда жасанды алмаздардың қолданылып жүргені қиындық туғызатынын атап өткен.

Keywords: «diamond», «equipment», «application», «stones», «properties», «tools», «hardness», «building».

Түйінді сөздер: «алмас», «техника», «қолданылуы», «тастар», «қасиет», «құралдар», «қаттылық», «құрылыс».

Ключевые слова: «алмаз», «техника», «применение», «камни», «свойства», «инструменты», «твердость», «строительство».

Diamond is a metastable 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 less stable than graphite, but the conversion rate from diamond to graphite is negligible at standard conditions. 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. Those properties determine the major industrial application of diamond in cutting and polishing tools and the scientific applications in diamond knives and diamond anvil cells.

Because of its extremely rigid lattice, it can be contaminated by very few types of impurities, such as boron and nitrogen. Small amounts of defects or impurities (about one per million of lattice atoms) color diamond blue (boron), yellow (nitrogen), brown (lattice defects), green (radiation exposure), purple, pink, orange or red. Diamond also has relatively high optical dispersion (ability to disperse light of different colors).

Most natural diamonds are formed at high temperature and pressure at depths of 140 to 190 kilometers (87 to 118 mi) in the Earth's mantle. Carbon-containing minerals provide the carbon source, and the growth occurs over periods from 1 billion to 3.3 billion years (25% to 75% of the age of the Earth). Diamonds are brought close to the Earth's surface through deep volcanic eruptions by magma, which cools into igneous rocks known as kimberlites and lamproites. Diamonds can also be produced synthetically in a HPHT method which approximately simulates the conditions in the Earth's mantle. An alternative, and completely different growth technique is chemical vapor deposition (CVD). Several non-diamond materials, which include cubic zirconia and silicon carbide and are often called diamond simulants, resemble diamond in appearance and many properties. Special gemological techniques have been developed to distinguish natural diamonds, synthetic diamonds, and diamond simulants. The word is from the ancient Greek ἀδάμας – adámas "unbreakable".

Naturalhistory. The formation of natural diamond requires very specific conditions—exposure of carbon-bearing materials to high pressure, ranging approximately between 45 and 60 kilobars (4.5 and 6 GPa), but at a comparatively low temperature range between approximately 900 and 1,300 °C (1,650 and 2,370 °F). These conditions are met in two places on Earth; in the lithospheric mantle below relatively stable continental plates, and at the site of a meteorite strike.

Misconception about diamonds forming from compressed coal. Few diamonds are formed from highly compressed coal. More than 99% of diamonds ever mined have formed in the conditions of extreme heat and pressure about 90 miles (140 km) below the Earth's surface. Coal is formed from prehistoric plants buried much closer to the surface and is unlikely to migrate below 2 miles (3.2 km) through common geological processes. Most diamonds that have been dated are older than the first land plants and are therefore older than coal. It is possible that diamonds can form from coal in subduction zones and in meteoroid impacts, but diamonds formed in this way are rare, and the carbon source is more likely carbonate rocks and organic carbon in sediments, rather than coal.

Material Properties. A diamond is a transparent crystal of tetrahedrally bonded carbon atoms in a covalent network lattice (sp3) that crystallizes into the diamond lattice which is a variation of the face centered cubic structure. Diamonds have been adapted for many uses because of the material's exceptional physical characteristics. Most notable are its extreme hardness and thermal conductivity (900–2320 W•m−1•K−1),[22] as well as wide bandgap and high optical dispersion. Above 1700 °C (1973 K / 3583 °F) in vacuum or oxygen-free atmosphere, diamond converts to graphite; in air, transformation starts at ~700 °C.[24] Diamond's ignition point is 720 – 800 °C in oxygen and 850 – 1000 °C in air. Naturally occurring diamonds have a density ranging from 3.15–3.53 g/cm3, with pure diamond close to 3.52 g/cm3. The chemical bonds that hold the carbon atoms in diamonds together are weaker than those in graphite. In diamonds, the bonds form an inflexible three-dimensional lattice, whereas in graphite, the atoms are tightly bonded into sheets, which can slide easily over one another, making the overall structure weaker. In a diamond, each carbon atom is surrounded by neighboring four carbon atoms forming a tetrahedral shaped unit.

Hardness. Diamond is the hardest known natural material on both the Vickers and the Mohs 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 <111> 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—perhaps contributing to its popularity as the preferred gem in engagement or wedding rings, which are often worn every

Chemical stability. Diamonds are not very reactive. Under room temperature diamonds do not react with any chemical reagents including strong acids and bases. A diamond's surface can only be oxidized at temperatures above about 850 °C (1,560 °F) in air. Diamond also reacts with fluorine gas above about 700 °C (1,292 °F).

Color. Diamond has a wide bandgap of 5.5 eV corresponding to the deep ultraviolet wavelength of 225 nanometers. This means pure diamond should transmit visible light and appear as a clear colorless crystal. Colors in diamond originate from lattice defects and impurities. The diamond crystal lattice is exceptionally strong and only atoms of nitrogen, boron and hydrogen can be introduced into diamond during the growth at significant concentrations (up to atomic percents). Transition metals nickel and cobalt, which are commonly used for growth of synthetic diamond by high-pressure high-temperature techniques, have been detected in diamond as individual atoms; the maximum concentration is 0.01% for nickel and even less for cobalt. Virtually any element can be introduced to diamond by ion implantation.

Nitrogen is by far the most common impurity found in gem diamonds and is responsible for the yellow and brown color in diamonds. Boron is responsible for the blue color. Color in diamond has two additional sources: irradiation (usually by alpha particles), that causes the color in green diamonds; and plastic deformation of the diamond crystal lattice. Plastic deformation is the cause of color in some brown and perhaps pink and red diamonds. In order of increasing rarity, yellow diamond is followed by brown, colorless, then by blue, green, black, pink, orange, purple, and red. "Black", or Carbonado, diamonds are not truly black, but rather contain numerous dark inclusions that give the gems their dark appearance. Colored diamonds contain impurities or structural defects that cause the coloration, while pure or nearly pure diamonds are transparent and colorless. Most diamond impurities replace a carbon atom in the crystal lattice, known as a carbon flaw. The most common impurity, nitrogen, causes a slight to intense yellow coloration depending upon the type and concentration of nitrogen present. The Gemological Institute of America (GIA) classifies low saturation yellow and brown diamonds as diamonds in the normal color range, and applies a grading scale from "D" (colorless) to "Z" (light yellow). Diamonds of a different color, such as blue, are called fancy colored diamonds, and fall under a different grading scale.

At the present stage of development of many industries technology can not do without the use of diamonds. Without the diamond tool can not be making parts of superhard material with a complex configuration. It was found that when grinding carbide diamond tool of its resistance increases twice.

Large economic effect is also obtained from the use of diamond tools for drilling, turning, grinding, broaching wire cutting, and so on. D. The treated diamond items of unprecedented quality, in addition, diamond tool can make details of superhard materials that are durable.

Diamond tools are widely used in engineering, aviation, automotive, machine tool, radio and electrical industry.

In connection with the widespread introduction of the diamond industry in our country organized a comprehensive study of its physical and chemical properties. Develop ways and methods of its technical application.

With the help of diamonds produced: processing tools and machine parts of cemented carbide; drilling exploration and production wells in the hard and abrasive rock; treatment of products from highly rigid and heat resistant materials - ceramics, synthetic corundum, quartz, glass, semiconductor materials - silicon and germanium and wall-building materials (granite, marble, etc...); dressing of grinding wheels;

Turning machine parts made of soft and non-ferrous metals and alloys, plastic and so on. etc .; drawing a thin wire of gold, platinum, silver, copper, tungsten, molybdenum, etc .; hardness control, accuracy, purity, surfaces of machine parts and tools. For each application requires certain quality of the crystals, size and weight.

In mechanical engineering is used diamond tools.

Diamond tools. With automatic processing of parts for high accuracy of geometric dimensions and high-grade surface finish must have a cutting tool, which would have high dimensional stability. This satisfies the requirements of the diamond cutting tool.

Diamond tools from diamond crystals are used in the metal industry for fine turning and boring, milling, engraving, drawing and cutting of glass; in the optical industry - for division of the scales, grids, dials, diffraction gratings, etc.

Diamond tools in the engineering industry can be divided into two main groups:

1) powders of diamond tools;

2) tools of the industrial diamond crystals.

The first group of tools 8+ include grinding wheels on metal and resin bond wheels, cutting, honing stones, needle files, diamond pastes and powders.

The second group of cutters, dies, pencils, needles and rollers for editing abrasive circles, and glaziers.

Tools of the second group are made of diamond crystals by grinding and polishing (cut).

For certain types of dressing tools and glass cutters are used rough diamonds.

The raw material for tools of diamond crystals are industrial diamonds, the higher quality in comparison with the diamond board, intended for crushing into powder.

Diamond powders. Diamond powders are crushed fragments of single crystals or a regular crystal form a certain size. Over half the size of the accepted amount length and width of the projection of the grain on a microscope slide.

Diamond powders are produced in accordance with GOST 9206-59 as shlifzerna, grinding powders and micro powders.

The grain size of diamond powders was determined using a microscope equipped with ocular scale or grid. microscopic analysis Results are expressed as a percentage of the grains for each fraction separately. The main fraction of diamond powder (in%) consists of a plurality of grains of a specific size by the number prevailing in the composition of the powder.

Diamond grinding wheels. Of all the diamonds used in industry today, 70% is used as a powder for making diamond wheels, bars, needle files and other instruments.

Diamond wheels consist of a body and a working diamond layer. Shells made of steel, aluminum alloys or polymers. The diamond layer is made of diamond powder, the ligaments and the filler.

Currently available in three types of circles - on metal, on organic and ceramic bonds.

Circles detachable diamond. Very effectively used diamonds for processing of non-metallic materials.

Most advantageously processed diamond tool nonmetallic materials having high hardness and friability. These include various kinds of ceramics, glass, ferrite, alumina, granite, diabase, semiconductor materials (germanium, silicon) and others.

Diamond pastes. On the basis of micron powders-AM1 AM40 manufactured diamond paste. When finishing and polishing diamond pastes have neskolno more proizaoditelnostyu.

Depending on the material, surface roughness requirements and process conditions used and the paste of diamond grit of varying concentration.

Diamond bars. Diamond bars are made mostly of synthetic diamond powders in the organic and metallic cords six sizes (tab. 9). Diamond sticks on metal bond grit recommended A8, A4, and bars on the organic binder-grain-AM40 AM10.

Diamond heads. Heads are diamond circles, pressed onto a cylindrical shaft. Bits produced on organic and metallic cords of the same grain size as circles and from pneumatic impellers operate at a rotation speed of up to 10,000 rev / min.

Bits are widely used in the processing of shaped holes in the details of hard alloys.

Diamond honing stones. Diamond honing stones are one of the most promising tools; they are 100 120 times more resistant than the abrasive bars. In addition, the high resistance of the diamond honing bars, rotary shaft allowed to drastically reduce the number of podnaladok machines and automate the process of Khonina-marina facilities, which occurs at low temperatures, cutting, thanks to the opportunity to handle thin-walled parts with large differences of the wall section.

Diamond cutters. The weight of diamonds is in the range 0.3-1.5 carats. Large crystals weighing more than 1 carat are used for cutting blades, smaller-for globe.

Designed for diamond cutters must have a dense structure, their working parts are not allowed external and internal cracks, sinks and inclusions visible under tenfold magnification. Also, there should be no internal stress in a diamond crystal, defined by the presence of double refraction beam zones under a polarizing microscope. Depending on the configuration and size of the diamond they are cutting, grinding, and attached to a tool holder designed by NIIAlmazom technology.

Diamond tools for dressing grinding wheels. Diamond grinding wheel dressing is one of the most important applications of diamonds in mechanical engineering.

Quality processing grinded parts, durability and range of grinding performance is largely determined by the accuracy of the form grinding wheel and its topographical surface layer, which depend on the design of the dresser, its durability, modes and methods of editing.

Diamond metal pens. The most widely used in the domestic industry received a diamond-metal pens, in which diamond grains cemented by a special alloy by powder metallurgy. This alloy has almost the same thermal expansion coefficient as the diamond, and so when you change the temperature of the metal-diamond pencil diamonds do not feel pressure. The range of diamond-metal pencils and their characteristics are determined by GOST 607-63.

Faceted diamond tools. They are used for straightening laps complex profile. They are produced in the form of tools with different profiles of diamond.

Cost faceted incisors significantly higher than the cost of diamonds in the mountings as diamond faceted crystal cutters need to be sanded.

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