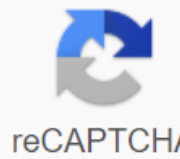


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To use graphene in commercial applications, a fast-growing list of graphene production methods has been developed. Isolated 2D crystals cannot be grown by chemical synthesis outside of small sizes, even in principle, because the rapid increase in the density of the phonon with an increase in lateral size causes 2D crystallites to bend in the third dimension. However, there are other ways to 2D materials: fundamental forces create seemingly insurmountable barriers to the creation of 2D crystals ... Emerging 2D crystallites try to minimize their surface energy and inevitably turn into one of the rich varieties of stable 3D structures that occur in so. But there is a way around this problem. Interaction with 3D structures stabilizes 2D crystals during growth. Thus, it is possible to make 2D crystals sandwiched between or placed on top of atomic planes in a crystal bulk. In this respect, graphene already exists in graphite... One can hope to deceive nature and extract crystallites one atom thick at a low enough temperature to keep them in the tempered state prescribed by the initial high-temperature 3D growth. Early approaches to the cleft of multi-layered graphite into individual layers or its epitaxial cultivation by depositing a carbon layer onto another material have been supplemented by numerous alternatives. In all cases, graphite must be associated with some kind of substrate in order to maintain its 2D shape. Exfoliation as exfoliation in 2014 produced graphene with the fewest defects and high electron mobility. The tape of Andre Geim and Konstantin Novoselov originally used duct tape to divide graphite into graphene. Achieving one layer usually requires several exfoliating stages, each of which silicates the lower layers while only one remains. After peeling, the flakes are deposited on a silicon plate. Crystallites are larger than 1 mm and visible to the naked eye can be obtained. A wedge based on this method, a sharp single-crystal diamond wedge penetrates the source of graphite to exfoliate layers. This method uses highly ordered pyrolytic graphite (HOPG) as the source material. The experiments were supported by molecular-dynamic modeling. Graphite reduction of P. Boehm once reported the production of monolayer flakes of reduced graphite oxide in 1962. The rapid heating of graphite oxide and exfoliation gives a highly dispersed carbon powder with several percent of graphene flakes. Reducing the volume of monolayer films of graphite oxide, such as hydrazine with annihilation in argon/hydrogen, also gave graphene films. Later, the oxidation protocol was expanded to give graphene oxide with an almost untouched carbon structure, which effectively remove functional groups, none of which was initially possible. The measured power of the charge carrier exceeded 1,000 centimeters (393.70 inches)/Vs. inches./Vs. oxide was carried out. In 2014, a haircut from graphite was made of unoxidized grapheneshoufence using facets that produce local haircut rates of more than 10x104. It was argued that this method is applicable to other 2D materials, including boron nitrid, molybdenum disulfide and other layered crystals. The Sonication Solvent-assisted scattering of graphite in a proper liquid environment can produce graphene by sonication. Graphene is separated from graphite by centrifuge, which gives the concentration of graphene first up to 0.11 mg/ml in N-methylpyrrolidone (NMP) and then up to 2.1 mg/ml in NMP. The use of suitable ion fluid as a dispersion liquid medium produces a concentration of 5.33 mg/ml. Maximum concentration is achieved at points where van der Waals' forces overcome the interactive forces between graphene sheets and solvent molecules. Adding surfactant to the solvent before the sound check prevents the reaction by adsorbing the surface of graphene. This leads to higher concentrations of graphene, but removing surfactant requires chemical treatment. The imilly fluids of Sonicating graphite at the junction of two unaccompanied liquids, primarily heptane and water, produced macro-scale graphene films. Graphene sheets are adsorbed to a high energy interface between heptan and water, where they are stored from rest. Graphene remained on the interface even when exposed to a force of more than 300,000 g. Dissolutions can evaporate. Sheets up to 95% transparent and conductive. Molten graphite salts can be corroded in molten salts to form various carbon nanostructures, including graphene. Hydrogen cations dissolved in molten lithium chloride can be discharged on cathode polarized graphite rods, which are then intercalated into a graphite structure, peeling graphite to produce graphene. The graphene nanolists produced displayed a single-crystal structure with a side size of several hundred nanometers and a high degree of crystallization and thermal stability. Electrochemical synthesis Electrochemical synthesis can exfoliate graphene. Change in the thickness of pulse voltage, the area of flakes, the number of defects and affects its properties. The process begins with bathing graphite in solvents for intercalation. The process can be tracked by tracking the transparency of the solution using LED and photodiode. Hydrothermal self-candech graphene was prepared using sugar (e.g. glucose, fructose, etc.) This bottom-up substrate-free synthesis is safer, easier and more environmentally friendly than peeling. The method can control the thickness starting monolayer for multi-layered. Epitaxy Epitaxy refers to the deposition of crystalline overlay on the crystalline substrate, where there is a registry between them. In some cases, epitaxial graphene layers are poorly combined with surfaces (Van der Waals forces) to preserve the two-dimensional electronic structure of the range of isolated graphene. An example of this weak compound is the epitaxial graphene on SiC and Pt (111). On the other hand, the epitaxial graphene layer on some metals can be strongly connected to the surface with covalent bonds. Properties of covalent cover graphene may differ from the properties of free-standing graphene. An example of such a strong compound is epitaxial graphene on Ru (0001). However, the connection is strong only for the first graphene on Ru (0001); the second layer is looser connected to the first layer and already has properties very close to the free standing graphene. Chemical vapor deposition Chemical Vapor Deposition (CVD) is a common form of epitaxy. The process of depositing solid material into a heated substrate through the decomposition or chemical reaction of the compounds contained in the gas passing through the substrate is called chemical vapor deposition. Reactive agents, usually in the gaseous or vapor phase, react to the surfaces of substrates or near them, which are at some elevated temperature. The subsequent reaction leads to the deposition of atoms or molecules on the entire surface of the substrate. GCC processes are also widely used to grow epitaxial layers, such as the epitaxial layer of silicon on a single crystalline silicon substrate (homoeptax, or commonly called epitaxy) or the deposition of the epitaxial layer on sapphire (heteroepitaxia). The special method in the GCC, called Epitaxy or Epitaxial Layer Deposition or Steam Phase Epitaxia (VPE), has only a single crystal form, both in the storage layer. This process is usually carried out for certain combinations of substrate and layered materials and under special deposition conditions. Epitaxia of graphene epitaxial graphene films can be grown on various crystal surfaces. The atomic lattice of the substrate facilitates the orientation of the registration of carbon atoms of the graphene layer. The chemical interaction of graphene with the substrate can range from weak to strong. It also changes the properties of the graphene layer. The need for epitaxial graphene is due to the challenges of incorporating carbon nanotubes into large-scale integrated electronic architectures. Thus, studies of 2D graphene were started by experiments on epitaxys of grown graphene on one crystalline silicon carbide. Despite significant control over the growth and characteristics of epitaxial graphene, problems remain associated with the ability to make full use of the potential of these The promise is to hope that the charge carriers on these these structures, such as carbon nanotubes, remain ballistic. If so, it could revolutionize the electronics world. Silicon Carbide Home article. Carbide-derived carbon-treated silicon carbide (SiC) to high temperatures (1100 degrees Celsius) at low pressure (No 10<sup>6</sup> torr) reduces it to graphene. This process produces epitaxial graphene with sizes that depend on the size of the plate. The polarity of SiC, used to form graphene, silicon or carbon-polar, strongly affects the thickness, mobility and density of the carrier. The electronic structure of graphene in the so-called Dirac cone structure was first visualized in this material. Weak anti-localization is observed in this material, but graphene produced by the drawing method is not exfoliated. Large, temperature-independent mobility is approaching the exfoliable graphene placed on silicon oxide, but lower than mobility in the hanging graphene produced by the drawing method. Even without the transfer of graphene on SiC demonstrates the mass-free fermions of Dirac. The interaction of graphene and substrate can be further passive. The weak power of van der Waals, which co-eats multi-layered stacks, does not always affect the electronic properties of individual layers. That is, while the electronic properties of some multi-layered epitaxial graphene are identical to those of one layer, other properties are affected because they are bulk graphite. This effect is well understood theoretically and is associated with the symmetry of interlayer interactions. Epitaxial graphene on SiC can be patterned using standard microelectronics techniques. The strip rupture can be created and configured by laser irradiation. Silicon/Germanium/hydrogen Normal Silicon plate, covered with a layer of germanium (Ge), dipped in diluted strips of hydrofluoric acid, naturally forming groups of oxide germanium, creating hydrogen-eliminated germanium. Chemical vapor deposition lays a layer of graphene on top. Graphene can be cleaned off with a dry process and then ready for use. The waflie can be reused. Graphene is wrinkle-free, high quality and of poor quality defects. Metallic single crystal substrates Metal single crystals are often used as substrates in the growth of graphene, as they form a smooth and chemically homogeneous platform for graphene growth. In particular, chemical uniformity is an important advantage of metal single-crystal surfaces: for example, on different surfaces of oxide the oxidized component and oxygen forms very different places of asorence. The typical metal single-crystal surface of the substrate is a hexagonal near-packed surface, as this geometry is also the geometry of carbon atoms in the graphene layer. Common surfaces, have hexagonal geometry closely packed, such as FCC (111) and HCP (0001) surfaces. Of course, similar surface geometries alone do not provide provide graphene asorpium on the surface, since the distances between surface metal atoms and carbon atoms can be different, leading to muor. Common metal surfaces for graphene growth are Pt (111), Ir (111), Ni (111), Ru (0001), Co (0001) and Cu (111), but at least Fe (110), Au (111), Pd (111), Re (1010) and Rh (111) were used. Techniques of preparing metal single crystalline substrates there are several methods of how good quality metal single crystal substrates can be manufactured. Czochralski and Bridgman-Stockbarger methods are common industrial methods of producing bulk metal crystals. In these methods, the metal is first melted, after which the metal allows to crystallize around the seed crystal. After crystallization, the crystal is cut with waffles. Another widely used method, especially in studies, is epitaxy, which allows the growth of numerous different metal single-crystal surfaces on some publicly available single crystals, such as monocystalline silicon. The advantage of epitaxy compared to industrial methods is the low consumption of the material; the epitaxial substrates thick in the nanometer scale can be manufactured to full self-sustaining waffles. This is especially important with rare and expensive metals such as rhenium and gold. Ruthenium (0001) Graphene can be grown on the surface of ruthenium (0001) with GCC, temperature programmed growth (TPG) or segregation. In the GCC, the hot surface of ruthenium is exposed to some carbons containing molecules such as methane or ethane. This leads to the formation of graphene. It was noted that graphene can only grow down from the ruthenium of the surface steps, not uphill. Graphene ties are strongly linked to covalent connections to the surface and has only a 1.45 euro separation to the surface. This affects the electronic structure of the graphene layer, and the layer behaves differently than the free-standing graphene layer. However, the growth of CVD graphene on ruthenium is not fully self-perfect and multi-layered graphene formation is possible. The second and higher layers cannot coerce the existing layers of graphene as strongly as the first layer of communication with the metal surface, resulting in a higher 3rd separation between the layers of graphene. Thus, the second layer has a much weaker interaction with the substrate and has very similar electronic properties as free-standing graphene. Because of the strong connection of graphene on the surface of the ruthenium, there is only an orientation of R0 on the graphene layer. Despite this, various studies have shown different lengths of moire repetition distances, varying around Graphene (11 x 11) and Ru (10 x 10). The muar model also causes a strong corrugation of the graphene layer, whose peak height 1.5 inches of Iridium (111) Graphene is usually deposited on iridium (111) of the GCC, but also with temperature programmed growth (TPG) (TPG) In GSS, the hot surface of iridium is exposed to ethylene. Ethylene decomposes on the surface due to pyrolysis, and formed carbon adsorbs to the surface form a graphene monolayer. Thus, only monolayer growth is possible. The formed graphene layer is loosely limited to the iridium substrate and is located on the surface at about 3.3 eVors. The graphene layer and the Ir substrate (111) also form a moire pattern with a period of about 25 th, depending on the orientation of graphene on Ir (111). There are many different possibilities for targeting the graphene layer, the most common of which are R0 and R30. The graphene layer also has corrugation due to moire, with the height varies from 0.04 to 0.3 ... due to the long-range order of these ripples, minipaps in the electronic strip structure (Dirac cone) become visible. Platinum (111) sheets of graphene were reportedly grown by substrate ethylene on a pure, single platinum (111) substrate at temperatures above 1000 degrees Celsius in an ultra-high vacuum (UHV). The graphene monolayer interacts poorly with the Pt surface (111) beneath it, confirmed by the local density of states, which is a form of "V". Kim et al reported on the electronic properties of graphene nanoribns, the geometry of which depends on the change in the temperature of the anneal and provide a fundamental understanding of the growth of graphene. Ni (111) with structural and electronic characteristics. Co (0001) lattice is ferromagnetic, but graphene monolayer, does not reduce spin polarities on Co (0001) does not show the Rashba effect. 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