{{Translating |time=2008-03-24T15:21:10+00:00 }}

{| width="300" border="1" cellpadding="2" cellspacing="0" align="right"

|+ <font size="+1">'''性質'''</font>

<!--

|-

| colspan="2" align="center" | INSERT PICTURE HERE -->

|-

! colspan="2" align="center" bgcolor="#FFDEAD" | '''一般'''

|-

| 名稱

| 氮化硼

|-

| [[化學公式]]

| [[硼|B]][[氮|N]]

|-

| [[外觀]]

| 白色固體

|-

| [[CAS號]]

| 10043-11-5

|-

! colspan="2" align="center" bgcolor="#FFDEAD" | '''物理學'''

|-

| [[原子量]]

| 24.818 g/mol

|-

| [[熔點]]

| 2967 °C

|-

| [[沸點]]

| 3273 °C

|-

| [[密度]]

| 2.18×10<sup>3</sup> [[kilogram|kg]]/[[metre|m]]<sup>3</sup>

|-

| [[晶體結構]]

| [[hexagonal]]或[[tetrahedral]]-[[cubic crystal system|cubic]]

|-

| [[可溶性]]

| 不可溶

|-

! colspan="2" align="center" bgcolor="#FFDEAD" | '''熱化學'''

|-

| [[標準摩爾生成焓|Δ<sub>f</sub>H<sup>0</sup><sub>gas</sub>]]

| 476.98 [[joule|kJ]]/[[mole (unit)|mol]]

|-

| Δ<sub>f</sub>H<sup>0</sup><sub>solid</sub>

| -250.91 kJ/mol

|-

| [[標準摩爾熵|S<sup>0</sup><sub>gas, 1 bar</sub>]]

| 212.36 J/mol•K

|-

| S<sup>0</sup><sub>solid</sub>

| 14.77 J/mol•K

|-

| [[溶化熱]]

| 3263.8 J/g

|-

! colspan="2" align="center" bgcolor="#FFDEAD" | '''安全'''

|-

| [[Risk phrases]]

| R36 R37

|-

| 注射

| ?

|-

| Inhalation

| ?

|-

| 皮膚

| ?

|-

| 眼部

| ?

|-

| 更多

| ?

|-

! colspan="2" align="center" bgcolor="#FFDEAD" | <font size="-1"> 此表適當時使用[[國際單位制|國際單位]]。除非另有註明，[[standard temperature and pressure|standard]] conditions were used.

[[Inorganic table information|Disclaimer and references]] </font>

|}

'''氮化硼'''（'''BN'''）是一種由相同數量的氮原子和硼原子組成的[[雙化合物]]，因此它的[[實驗式]]是BN。氮化硼和[[碳]]是[[等電子體|等電子]]的，並和碳一樣，氮化硼是[[多形]]的：其中一形體類似於[[鑽石]]而另一個則類似於[[石墨]]。類似於鑽石的形體是現時所知的最硬的物質，類似於石墨的形體是一種十分實用的潤滑劑。

==六邊形氮化硼==

形態相似於石墨的氮化硼，也稱六邊形氮化硼、h-BN、α-BN或g-BN （graphitic BN），有時也稱“白石墨”，它是最普遍使用的氮化硼形態。<ref>Jochen Greim, Karl A. Schwetz “Boron Carbide, Boron Nitride, and Metal Borides” in Ullmann's Encyclopedia of Industrial Chemistry Wiley-VCH: Weinheim: 2005. DOI: 10.1002/14356007.a04\_295.pub2</ref>和石墨相似，Hexagonal形態是由許多片六邊形組成。這些薄片的interlayer "registry"不同，但是從石墨的排列模式中看出，這是由於硼原子在氮原子上面使氮化硼的原子變成橢圓的。這樣的registry反映出硼—氮鏈的極性。氮化硼中較低的covalency使它成爲導電性相對於石墨較低的[[半金屬]]，電在它六邊形薄片中pi-鏈的網絡中流通。The diminished electron-delocalizaton in hexagonal-BN is indicated by its absence of color, which signals a large [[band gap]].

六邊形氮化硼在極低和極高（900 °C）的溫度甚至是氧氣下都是一種很好的潤滑劑，它在石墨的導電性和與其它物質的化學反應造成困難時特別有用。由於它的lubricity mechanism並不涉及到層面之間的水分子，氮化硼潤滑劑還可以在真空下使用，如在太空作業時。

六邊形氮化硼在空氣中高達1000 °C、真空中1400 °C和在惰性氣體中2800 °C都仍然穩定，也是其中一種導熱性最好的絕緣體。它對多數物質都不產生化學反應，也不被許多融化物質所[[浸潤|沾濕]]（如：[[鋁]]、[[銅]]、[[鋅]]、[[鐵]]和[[鋼]]、[[鉻]]、[[硅]]、[[硼]]、[[冰晶石]]、[[玻璃]]和[[滷化鹽]]。{{Fact|time=2007-12}}）

細粒的h-BN被用於一些[[化妝品]]、[[顔料]]、dental cements和[[鉛筆]]芯。{{Fact|time=2007-12}}

====製造六邊形氮化硼====

六邊形氮化硼可由[[三氯化硼]]經過[[氮化]]或[[ammonolysis]]后製作而成。六邊形氮化硼部件可由加熱加壓和其後的機械加工造出，因爲它的硬度與石墨相當，所以加工成本不高。這些部件都由氮化硼粉末製造，以[[氧化硼]]作爲[[燒結]]劑。氮化硼薄膜可以由[[三氯化硼]]和[[氮]]雛形[[化學氣相沉積]]後形成。而工業製造是基於兩個化學反應：熔化的硼酸與氨、硼酸或鹼性硼化物與[[尿素]]、[[胍]]、[[蜜胺]]或其他適當的氮氣中的有機氮化合物。製作超細氮化硼潤滑劑和[[toner]]則需要在氮氣中以5500°C高溫燃燒硼粉末。

<gallery>

Image:Boron-nitride-(hexagonal)-side-3D-balls.png|<center>α-BN, hexagonal </center>

Image:Boron-nitride-(hexagonal)-top-3D-balls.png|<center>α-BN, hexagonal</center>

Image:Boron-nitride-(sphalerite)-3D-balls.png|<center>β-BN, [[sphalerite]] structure</center>

Image:Boron-nitride-(wurtzite)-3D-balls.png|<center>BN, [[wurtzite]] structure</center>

</gallery>

==正方體氮化硼==

正方體氮化硼極其堅硬，儘管硬度仍低於[[鑽石]]和其他相似物質。和鑽石相似，正方體氮化硼是一種[[絕緣體]]但卻是一種極佳的導熱體。結構類似於鑽石的氮化硼形態，也叫正方體氮化硼、c-BN、β-BN、或z-BN（以[[鋅混合物]]晶體結構命名），是被廣泛使用的工業[[鑽磨]]工具。{{Fact| time=2007-12}}它如此有用是因爲它在[[鐵]]、[[鎳]]和其他高溫合金中是不可溶的，而鑽石在這些物質中是可溶的並會製造出碳化物。多晶體c-BN鑽磨工具多用於機械鋼鐵，同時鑽石鑽磨工具就被用於鋁合金、陶器和岩石。如鑽石一樣，正方體氮化硼由於[[聲子]]有著高傳熱性。在高溫中與氧接觸，氮化硼會形成一個氧化硼的passivation層。氮化硼可以和金屬很好地結合，這是因爲硼或氮合金interlayer的形成。正方體氮化硼晶體材料常被用在[[切割工具]]的[[tool bit]]s。用於磨碎物品時，更軟的粘合劑會被使用，如：合成樹脂、porous ceramics等等，陶制粘合劑也會被使用。商業產品are known under names“Borazon”（by Diamond Innovations)和“Elbor”或“Cubonite”（by Russian vendors）。

Sintered cubic boron nitride is an electrically insulating [[heatsink]] material of potential value in [[microelectronics]].

====製造正方體氮化硼====

正方體氮化硼的製作可由在高溫、高壓下處理六邊形氮化硼而成，就如[[synthetic diamond]]從石墨製成相似。從六邊形氮化硼直接轉爲正方體氮化硼的過程需要在18百萬帕的壓力和介乎1730與3230 °C的溫度下發生；額外加入小量的氧化硼可以把所需的壓力降到4至7百萬帕和溫度降到1500 °C。在工業裏，人們會使用催化法轉化氮化硼，而不同的催化劑物質會用在不同的生産方法上，例如[[鋰]]、[[鉑]]或[[鎂]]、他們的氮化物，他們的氟氮化物、水再加上氨化合物或肼。其他工業合成法會使用溫差下結起的晶體或者爆炸產生的[[衝擊波]]。衝擊波的應用是用來製作出一種稱爲[[heterodiamond]]的超硬的硼、碳和氮的化合物。

低壓下正方體氮化硼薄膜的淤積是有可能的。For selective etching of the deposited hexagonal phase during [[chemical vapor deposition]], [[三氟化硼]]會被使用（''cf.'' use of atomic hydrogen for selective etching of graphite during deposition of diamond films）。[[Ion beam deposition]], [[Plasma Enhanced CVD]], [[pulsed laser deposition]], [[reactive sputtering]], and other [[physical vapor deposition]] methods are used as well.

==其他氮化硼形態==

===w-BN===

也成爲w-BN，六邊形氮化硼是發生在高壓環境下的一種超硬狀態。這種六邊形形態differs from the layered graphitic material: it adopts the [[wurtzite]] structure.

===三角晶氮化硼===

三角晶氮化硼相似於六邊形氮化硼。它會在正方體氮化硼轉化為六邊形氮化硼的過程中產生。

===氮化硼纖維===

六邊形氮化硼可以被製作成纖維的形態，由於和[[碳纖維]]結構相似，氮化硼纖維也被稱爲“白碳纖維”。它可以由受擠壓的[[環硼氮烷]]纖維再加上[[氮]]中的氧化硼於1800 °C下的熱力分解製成。這種物質也可經過[[纖維素]]纖維浸泡於超過1000 °C 的氨氣和氮氣中的[[硼酸]]或[[四硼化氨]]之後產生的熱力分解製成。Boron nitride fibers are used as reinforcement in [[composite material]]s, with the matrix materials ranging from organic resins to ceramics to metals (see [[Metal matrix composites]]).

{{TransH}}

==納米結構下的氮化硼==

===氮化硼納米管===

Like BN fibers, [[boron nitride nanotubes]](BNNTs) show promise for aerospace applications where integration of boron and in particular the light isotope of boron (<sup>10</sup>B) into structural materials improves their radiation-shielding properties, due to <sup>10</sup>B's neutron absorption properties. Such <sup>10</sup>BN materials are of particular theoretical value as composite structural material in future manned interplanetary spacecraft, where absorption-shielding from cosmic ray spallation neutrons is expected to be a particular asset in light construction materials.[http://wwwrsphysse.anu.edu.au/nanotube/bnnts.php]

===氮化硼nanomesh===

[[Image:nanomesh\_3D.jpg|thumb|Perspective view of nanomesh (structure ends at the back of the figure)]]

[[nanomesh | Boron nitride nanomesh ]] is a new [[inorganic]] nanostructured two-dimensional material.

It consists of a single layer of hexagonal boron nitride on [[rhodium]] or [[ruthenium]], forming a highly regular mesh. The distance between two pore centers is 3.2 [[nanometer]]s and the pores are 0.05 [[nanometer]] deep.

The boron nitride nanomesh is stable under vacuum, air and some liquids, but also up to temperatures of 796 <sup>o</sup>C. In addition, it shows the extraordinary ability to trap [[molecules]] and metallic [[cluster\_%28physics%29|clusters]]. These characteristics promise interesting applications of the [[nanomesh]] in [[nanotechnology]].

===Amorphous boron nitride===

Layers of amorphous boron nitride (a-BN) are used in some [[semiconductor devices]], eg. [[MISFET]]s. They can be prepared by chemical decomposition of [[trichloroborazine]] with [[caesium]], or by thermal [[chemical vapor deposition]] methods. Thermal CVD can be also used for deposition of h-BN layers, or at high temperatures, c-BN.

===BN-based fullerenes===

The [[fullerene]]-like forms of boron nitride can be synthesized and structurally resemble carbon [[carbon nanotube]]s. The recently discovered boron nitride [[nanotube]]s are an important development due to their homogeneous electronic behavior. That is, tubes of different [[chirality (chemistry)|chiralities]] are all [[semiconductor material]]s with the same (approximate) band gap.

==Composites containing BN==

Addition of boron nitride to [[silicon nitride]] ceramics improves the [[thermal shock]] resistance of the resulting material. For the same purpose, BN is added also to silicon nitride-[[alumina]] and [[titanium nitride]]-alumina ceramics. Other materials being reinforced with BN are e.g. alumina and [[zirconia]], [[borosilicate glass]]es, [[glass ceramic]]s, [[vitreous enamel|enamel]]s, and composite ceramics with [[titanium boride]]-boron nitride and titanium boride-[[aluminium nitride]]-boron nitride and [[silicon carbide]]-boron nitride composition.

Due to its excellent dielectric and insulating properties, BN is used in electronics e.g. as a substrate for semiconductors, microwave-transparent windows, structural material for seals, electrodes and catalyst carriers in [[fuel cell]]s and batteries.

h-BN can be included in ceramics, alloys, resins, plastics, rubbers and other materials, giving them self-lubricating properties. Such materials are suitable for construction of e.g. [[bearing]]s. Plastics filled with BN have decreased thermal expansion, increased thermal conductivity, increased electrical insulation properties, and cause reduced wear to adjacent parts.<!--poor construction-->

{{TransF}}

==參見==

\*[[Beta carbon nitride]]

\*[[Borazon]]

\*[[Boron phosphide]]

\*[[Boron suboxide]]

\*[[氮化鋁]]

\*[[Wide bandgap semiconductors]]

==參考資料==

{{Reflist}}

{{Refimprove|date=2008年1月}}

==外部鏈接==

\*[http://www.npi.gov.au/database/substance-info/profiles/15.html National Pollutant Inventory: Boron and Compounds]

\*[http://www.fiz-chemie.de/infotherm/html/molpages/00%5C35%5C/mol3597.html Fiz Chemie Berlin] thermophysical database

\*[http://ptcl.chem.ox.ac.uk/MSDS/BO/boron\_nitride.html Materials Safety Data Sheet] at University of Oxford

[[Category:硼化合物]]

[[Category:Ceramic materials]]

[[Category:III-V compounds]]

[[Category:潤滑劑]]

[[Category:氮化物]]

[[Category:半導體材料]]

[[Category:超硬材料]]

[[cs:Nitrid boritý]]

[[de:Bornitrid]]

[[en:Boron nitride]]

[[es:Nitruro de boro]]

[[eo:Bornitrido]]

[[fr:Nitrure de bore]]

[[it:Nitruro di boro]]

[[nl:Boornitride]]

[[ja:窒化ホウ素]]

[[pl:Azotek boru]]

[[pt:Nitreto de boro]]