elementsix™
ADVANCING DIAMOND

ABN

CUBIC BORON NITRIDE ABRASIVES

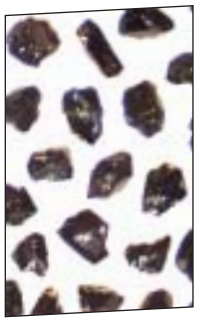
(3.3.5)

The ABN Range

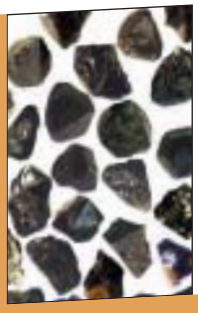
ABN800 is a dark brown coloured, strong and very thermally stable abrasive. The particle shapes are sharp and angular, with a predominantly truncated tetrahedral morphology. This unique combination of desirable crystal characteristics makes it highly suited for use in the most demanding vitrified bond applications.

ABN600 is a black, blocky shaped, high strength abrasive with good thermal stability. It is used primarily in sintered and electroplated metal bonds where the impact loads on the abrasive particles are high, and also in certain other applications where a strong, blocky particle with a relatively negative rake angle is required.

ABN300 comprises clear amber coloured, irregular shaped, friable crystals. It is of a similar strength to ABN200, with a different crystal morphology and, hence, different fracture characteristics. In addition, its surface characteristics make it ideally suited for use in a wide range of electroplated tools.



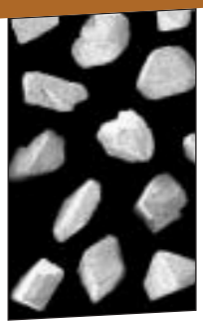
ABN200 consists of black, friable, irregular shaped particles. Its strength, thermal stability and sharpness make it particularly suitable for a wide range of standard vitrified bond applications. The fracture characteristics of the grit ensure that, on impact, small fragments break away from each particle. This contributes to free cutting characteristics combined with good wheel life.



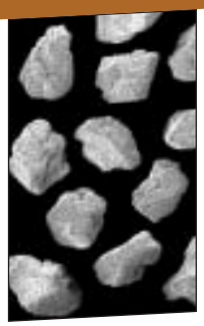
ABN605, available in coarse sizes between 30/35 and 50/60 US mesh, is monocrystalline and predominantly black in colour with a high impact strength. The particles are sharp and angular in shape with a degree of irregularity to assist in good bond retention in, for example, electroplated tools.

ABN abrasives in their unclad form are used predominantly in vitrified, electroplated and sintered metal bond systems.

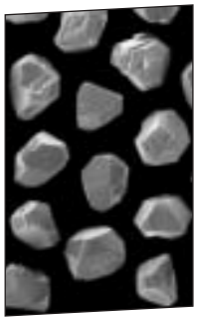
ABN Metal Clad Range



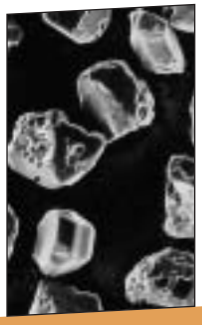
ABN860 is ABN800 clad to 60% by weight with electroless nickel. The unusual combination of high particle strength together with the sharp cutting characteristics of ABN860 makes it ideal for efficient use in demanding high performance resin bond applications.



ABN260 is ABN200 clad to 60% by weight with electroless nickel and is suitable for use in a wide variety of resin bonds. The surface texture and shape of the ABN200 substrate and the method of coating ensure a good adhesion between substrate and cladding, and the rough surface of the cladding ensures good retention in the bond. ABN260 is suitable for use in both wet and dry grinding applications.



ABN615 consists of ABN600 with a thin titanium coating. This coating offers a protective thermal and chemical shield to the particles. The technique of coating does not affect the strength of the grit particles. In certain bond systems, this coating protects the surface of the cBN particles from destructive chemical attack, and under suitable conditions can improve the grit retention in the bond.



MICRON+ ABN is produced by proprietary processing techniques. This product, which consists uniformly of irregular shaped particles carefully graded into discrete size ranges, is ideally suited for grinding, lapping and fine finishing of hard ferrous materials.

The majority of resin bond tools utilise ABN abrasives in a metal clad form. Element Six offers ABN with a 60% by weight electroless nickel cladding. This is available as standard in ABN260 and ABN860. In addition, a thin titanium cladding is offered on ABN600, which is designated as ABN615.

The Product Range

Cubic boron nitride (cBN) is the second hardest known material, only diamond being harder. cBN is synthesised from hexagonal boron nitride under conditions similar to those used to produce synthetic diamond from graphite. The desirable characteristics of an abrasive include high hardness, abrasion resistance, strength and resistance to thermal and chemical attack whilst maintaining sharp cutting edges during use. Compared to conventional abrasives such as silicon carbide and aluminium oxide, cBN exceeds their values in most of the key requirements. Its properties of high thermal stability and resistance to chemical attack make it suitable for machining ferrous materials, an area where diamond abrasives are not normally employed. (Element Six offers a complementary range of diamond abrasives - the PremaDia range - for machining non-ferrous materials.)

Hardness is a very important physical property of an abrasive. Most abrasive materials lose hardness at elevated temperatures. One of the physical advantages of cBN, compared to conventional abrasives, is that, in addition to being harder at ambient temperature, it maintains this hardness advantage over a wide temperature range. To provide the toolmaker with a choice of abrasive to enable optimisation of the tool for a specific application, the Element Six ABN range now comprises five products: ABN200, ABN300, ABN600 and ABN800, together with ABN605 in the coarser sizes. Each provides different crystal strength, degree of thermal stability, crystal morphology and particle shapes.

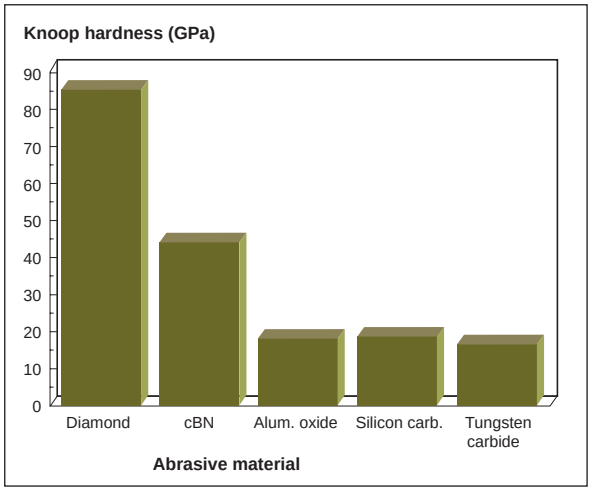


fig. 1 Hardness of a selection of abrasives at room temperature.

Applications

ABN abrasives generally provide higher productivity compared to conventional abrasives when grinding, honing and fine finishing hardened ferrous materials and difficult-to-machine alloys. These include, for example:

- hardened carbon steels
- alloy tool steels
- bearing steels
- cast irons
- superalloys
- hard stainless steels

Historically, the main use for cBN was in tool and cutter grinding of high speed steels. While this remains an important application area, cBN is also firmly established in production grinding in the engineering, automotive and aerospace industries. In these modern industries all four main bond types are used: resin, vitrified, electroplated and sintered metal. The ABN range offers a comprehensive choice of products.

Particle strength

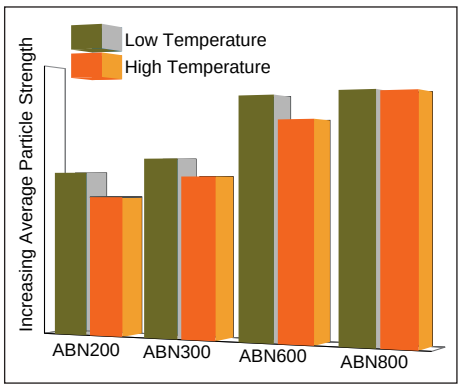


fig. 2

Average particle strength is one of the determinants used by the toolmaking industry for abrasive selection. ABN200 and ABN300 have similar particle strengths, but their crystal morphologies and fracture characteristics differ. Under impact loading, both products exhibit a controlled breakdown characteristic ensuring that a sharp cutting action is maintained. However, the fragments which break away from particles of ABN200 are smaller than those breaking away from ABN300.

ABN600 and ABN800 have similar particle strengths, but their crystal morphologies differ. In common with most cBN materials, ABN200, ABN300 and ABN600 exhibit some measurable and controlled reduction in strength when exposed to elevated temperatures. By contrast, ABN800 has a very high thermal stability and shows no significant reduction in impact strength after heating to a temperature of 1100°C.

Crystal morphology

For many years Element Six has used a simple system of crystal identification to describe the morphology of diamond and cBN particles - the Morphology Index. This index describes the range of crystal forms which can be produced dependent upon the growth conditions prevailing during synthesis. The selected conditions influence the relative growth rates of the different crystal faces or planes, which determine the final morphology and shape. The final form influences both the physical and chemical properties of the particle, and hence its behaviour during use.

The morphology of cBN allows for the manufacture of more crystal forms than that of diamond. Diamond crystal morphologies range from pure cubic to octahedral, depending on the relative rates of growth of the main crystal faces. In the case of cBN, the crystal morphology can also range between these two extreme forms and, in addition, under suitably controlled synthesis conditions, tetrahedral forms can be produced.

Element Six has selected five different domains in the morphology chart in which to produce its five ABN products *(fig. 3)*. They each therefore exhibit differences in fracture mechanism and surface chemistry, in addition to the differences in other physical properties of, for example, impact strength at both low and elevated temperatures, colour and overall crystal shape.

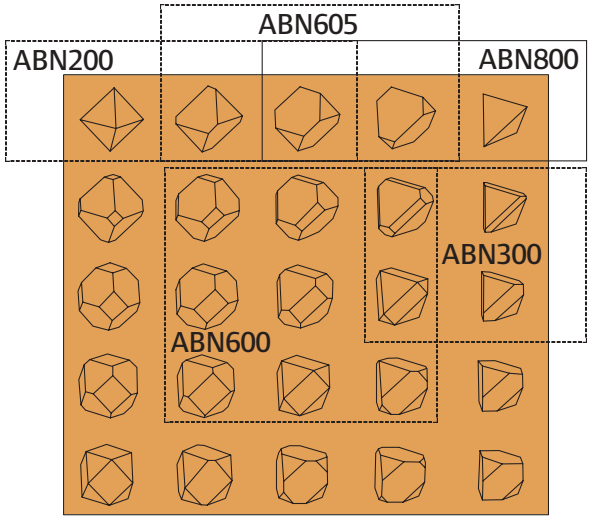


fig. 3

Metal clad ABN for resin bonds

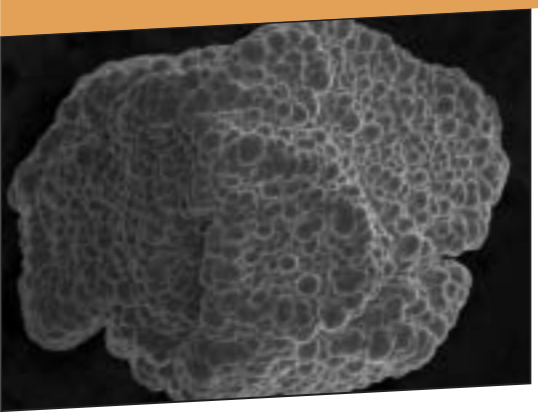


fig. 4 ABN260

Resin bond cBN tools are widely used in industry. They are relatively easy to use in a wide range of applications, typically in the machining of high speed steels and some superalloys. Most resin bond ABN tools incorporate the abrasive in a metal clad form. The advantages are two-fold:

- to improve heat dissipation.
- to improve retention of the particles in the bond.

In turn, these benefits result in enhanced performance and increased tool life. During machining, high temperatures are developed instantaneously between the abrasive particle and the workpiece. ABN has a high thermal conductivity, approximately double that of copper at room temperature. The nickel cladding has a lower thermal conductivity than the ABN, thus reducing the severity of the heat pulse to the resin bond. In addition, due to the larger surface area of metal clad resin bond grits compared to unclad abrasives, lower temperatures are produced at the interface with the bond material. The outer surface of the cladding is designed to be rough in texture. This results in a further contribution to the increase in surface area, and also improves retention of the abrasive in the bond *(fig. 4)*.

The chemical process for depositing the electroless nickel cladding is initiated and controlled to ensure optimum adhesion between the nickel and the ABN, and the chemical composition of the metal alloy is designed to prevent embrittlement caused by the thermal cycling encountered during machining.

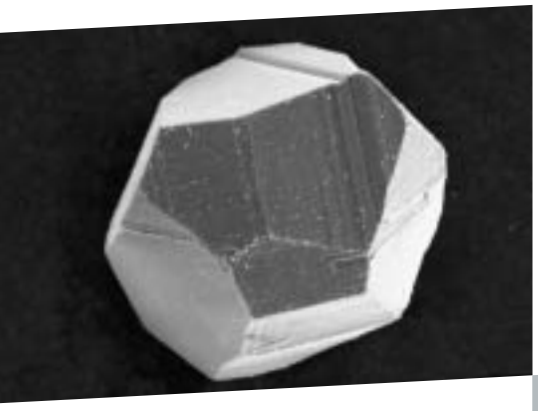


fig. 5 ABN615

Metal clad ABN for vitrified and metal bonds

For use in certain vitrified and metal bond systems, a protective coating of titanium is available which offers a thermal and chemical shield during tool manufacture *(fig. 5)*.

Standard cladding options

Standard Cladding Options

	Unclad	Nickel	Titanium
ABN200	✔	✔	
ABN300	✔		
ABN600	✔		✔
ABN800	✔	✔	

Physical properties

Product	Density g/cm³	Clad Weight (%)
ABN200	3.48	-
ABN260	5.30	60
ABN300	3.48	-
ABN600	3.48	-
ABN 605	3.48	-
ABN615	3.55	*
ABN800	3.48	-
ABN860	5.30	60

* *Consistent thickness of titanium coating across the size range.*

Size availability

The sizing of all products is carried out under strictly controlled conditions in accordance with the FEPA/ANSI international sieving specifications. The table below shows the available standard sizes in US mesh and FEPA specifications. Other sizes are available on request. In all cases, the size refers to the unclad particle.

Micron+ ABN is available in a range of graded micron products produced in closely controlled sizes between 0 - 0.5 and 40 - 80 µm.

US mesh	FEPA	ABN 200 ABN260	ABN 300	ABN 600 ABN 615	ABN 800 ABN 860	ABN 605
30/40	B602					✔
35/45	B502					✔
40/50	B427					✔
45/60	B357					✔
50/60	B301					✔
60/80	B252	✔	✔	✔	✔	
80/100	B181	✔	✔	✔	✔	
100/120	B151	✔	✔	✔	✔	
120/140	B126	✔	✔	✔	✔	
140/170	B107	✔	✔	✔	✔	
170/200	B91	✔	✔	✔	✔	
200/230	B76	✔	✔	✔	✔	
230/270	B64	✔	✔	✔	✔	
270/325	B54	✔	✔	✔	✔	
325/400	B46	✔	✔	✔	✔	

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