

elementsix™

DE BEERS GROUP



**Innovative synthetic
diamond and cBN
grit solutions**
for the automotive and
aerospace industries

e6.com

Unrivalled product offerings

Element Six's range of precision grinding solutions delivers extreme performance, across multiple industries. From the most demanding applications in automotive and aerospace manufacturing to the wider market for grinding tools, our assured quality and value give tool-makers a competitive edge.

Element Six offers premium diamond and cBN solutions, each range having its own benefits due to the unique mix of strength, shape and wear characteristics that can be enhanced further utilising our coating technology.

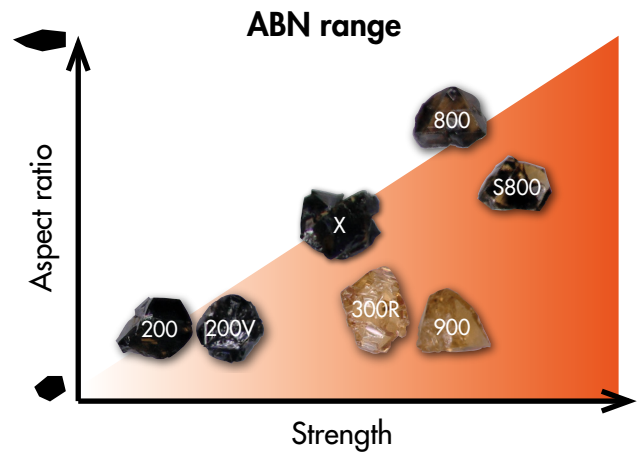
ABN range an ideal solution for grinding ferrous materials

cBN is the material of choice when grinding ferrous components at high speed and high temperature, due to its superior chemical and thermal stability.

Element Six's ABN range covers a wide array of grinding applications in the automotive and aerospace industries. This is the preferred range when grinding different types of steels, cast irons, as well as heat resistant alloys (HRSA). Some of the main components successfully ground using ABN products include: cam/crankshaft, bearings, gears, valves, turbine blades and HSS tools.



ABNS800: our signature solution
 The tailored ABN800 Signature Range has been introduced to provide optimal cBN grit characteristics to satisfy specific customer requirements in terms of performance and bond compatibility.



	Description	Application
ABN900	Strong amber cBN product with micro-fracturing characteristics delivering a free cutting behaviour (low forces and longer tool life)	Single layer (electroplated) tools. Particularly successful in grinding HRSA
ABN800	Strong and thermally stable brown coloured cBN, sharp and angular particles with truncated tetrahedral morphology	Vitrified bonds in camshaft and crankshaft grinding, bearings and HRSA grinding
ABNS800	Customisable offering for improved grinding performance, reducing heat build up and excessive wheel wear in grinding applications	
ABNX	Brown cBN value offering	Cost-effective solution for camshaft and crankshaft grinding
ABN300R	Clear amber, irregularly shaped particles, cost-effective solution	High tolerance gear grinding and outer diameter (OD) roughing operations
ABN200	Black, friable grit with lower thermal stability and irregularly shaped particles	Vitrified bonds for ball bearing, double disc grinding, finish grinding and hardened steel bearings
ABN200V	Cost-effective solution for vitrified bonds for ball bearing, double disc grinding, finish grinding and hardened steel bearings	Resin bonds for tool grinding

PremaDia developed for high performing non-ferrous grinding applications

The PremaDia range extends from PDA999, which is a high-strength crystalline abrasive suitable for demanding applications and high production rates, to the micro-chipping PDA321 and PDA211, particularly suited for grinding cemented tungsten carbides and hard ceramics.



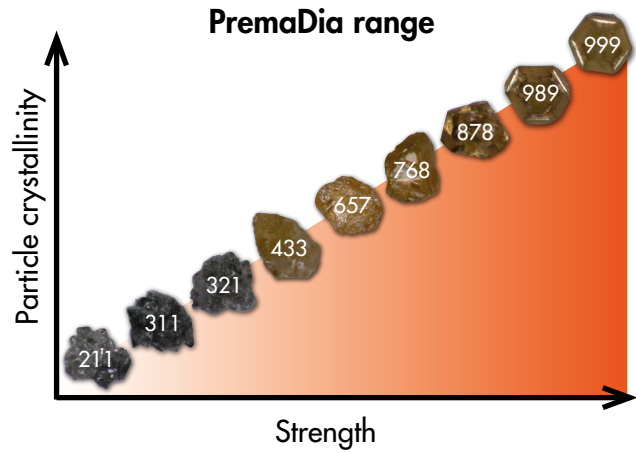
PDA999



PDA433



PDA211



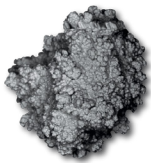
	Description	Application
PDA999	Highly crystalline diamond with the highest impact strength, thermal stability and uniform particle shape	Metal bonds and electroplated (single layer) tools
PDA989		
PDA878	Crystalline material with good impact strength at room and high temperatures	Vitrified and metal bonds and electroplated (single layer) tools
PDA768	Strong, well shaped synthetic diamond with sharp and blocky particles	Used in a broad spectrum of applications Resin, vitrified, hybrid and metal bonds and electroplated (single layer) tools
PDA657	Consistent but irregular crystal shape. Suited for less demanding applications where sharpness of edges is crucial	Clad version, ideal for combination material grinding (tungsten carbide (WC) + steel)
PDA446	Free cutting particles with controlled strength	Resin, vitrified, hybrid and metal bonds
PDA433	Friable grit used in a wide range of applications	
PDA321	Micro-chipping structure which ensures the degree of friability required for high quality resin bonded tools	Resin and vitrified bonds
PDA311	Friable wheel grit primarily designed for resin bonded tools	Resin bonds Particularly successful in WC grinding applications
PDA211	The most friable diamond wheel grit with micro-chipping properties. Highly efficient in grinding of cermet and ceramic workpieces	Resin bonds Particularly successful in cermet grinding applications

Coatings and claddings



TF coating

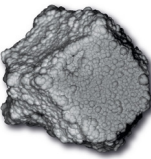
Using an active coating technology, this titanium carbide coating is chemically bonded to the abrasive particle, offering protection from degradation during toolmakers sintering processes and providing enhanced particle retention in the metal bond matrix. Improved particle retention enables particle protrusion, allowing for more efficient grindings, whilst maintaining and increasing tool life.



NX cladding

Electroless nickel cladding is deposited chemically. The chemical composition of the cladding is designed to prevent embrittlement caused by thermal cycling encountered during machining. The inherently designed roughness of the NX cladding ensures maximum retention and wetting between the resin and the clad abrasive particles, even in demanding applications.

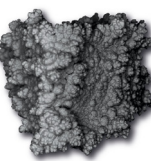
Available for items in the PremaDia range with a 30% and 55% by weight cladding and a 60% by weight cladding in the ABN range.



N cladding

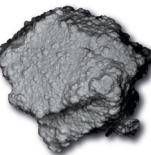
Electroless nickel cladding is deposited chemically. The chemical composition of the cladding is designed to prevent embrittlement caused by thermal cycling encountered during machining.

Available for items only in the ABN range with a 60% by weight cladding.



P cladding

The electrolytic cladding system used by Element Six results in a metallic nickel cladding with a high level of chemical purity. This 60% by weight metal cladding (P60) provides a mechanically tough coating and can be used in polyimide bond applications. The cladding has a very rough surface, aiding abrasive retention in the bond under severe grinding conditions.



C50 cladding

Copper cladding in a resin bond has been found to be particularly effective in the dry grinding of cemented carbides. The electroless copper cladding, C50 (50% by weight metal), has a higher thermal conductivity than nickel, improving the transfer of heat from the grinding zone when acting in conjunction with bonds which have enhanced thermal properties.

ABN and PremaDia solutions for automotive manufacturing

Bearings

**Vitrified bonded tools
(large grinding contacts):**
ABN200V & ABNX

**Vitrified bonded tools
(small grinding contact areas):**
ABN800 & ABNS800

Camshafts

Vitrified bonded wheels:
ABN200, ABN200V, ABN800,
ABNS800 & ABN900

Plated tools:
ABN300R & ABN900

Crankshafts

Vitrified bonded wheels:
ABN200, ABN800, ABNS800,
ABN900 & ABNX

Plated tools:
ABN300R & ABN900

CV joints

Vitrified bonded wheels:
ABN200, ABN200V, ABN800,
ABNS800 & ABN900



Gear teeth

Vitrified bonded tools:
ABN800 & ABNS800

Plated tools:
ABN900 & ABN300R

Windscreens

Metal bonded tools:
PDA989, PDA878, PDA768
& PDA657

Coated products are advised

Valves

Plated tools:
ABN900 & ABN300R

Vitrified bonded tools:
ABN200V, ABN200, ABN800
& ABNS800

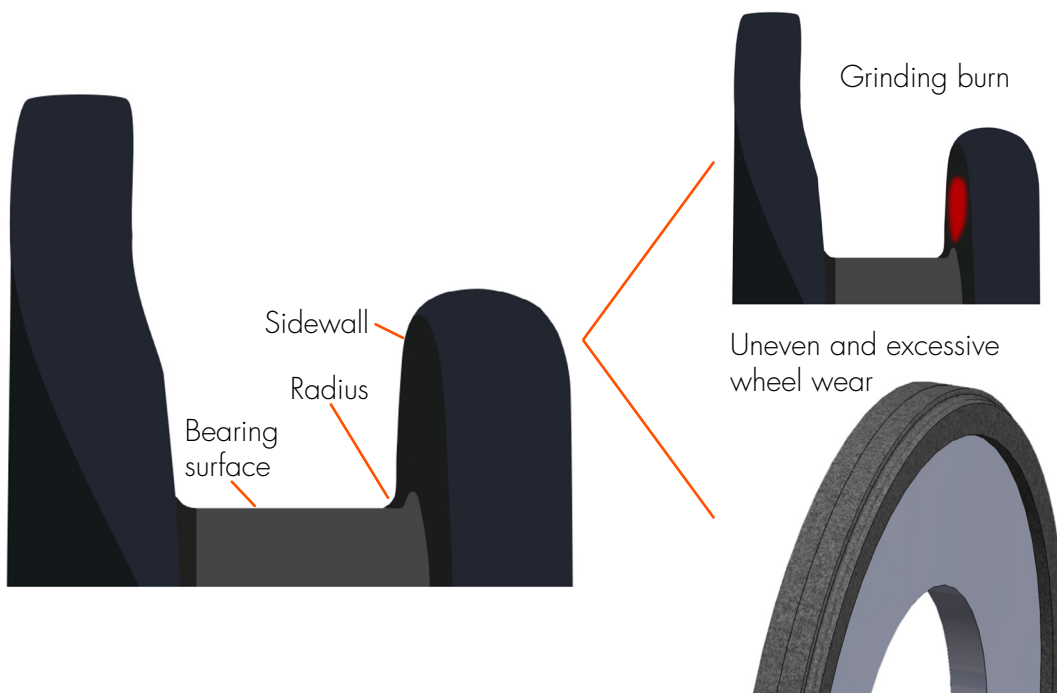
Grinding of crankshaft case study



Challenges

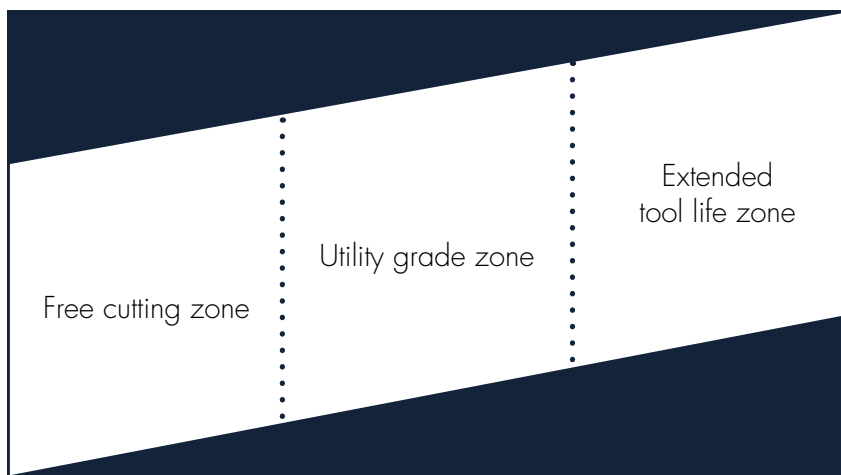
Stringent emission regulations call for improvements of the functional performance of key engine components, such as crankshafts, by tightening geometrical and surface requirement specifications. Being the final stage of crankshaft manufacturing, grinding is a challenging process, especially for the crankpin.

The kinematics variation across the profile of the crankpin can lead to grinding burn on the side wall and uneven grinding wheel wear.



Solution: **ABNS800**

ABNS800 provides optimal grit characteristics to satisfy specific requirements in terms of performance and bond compatibility, reducing and eliminating grinding challenges.

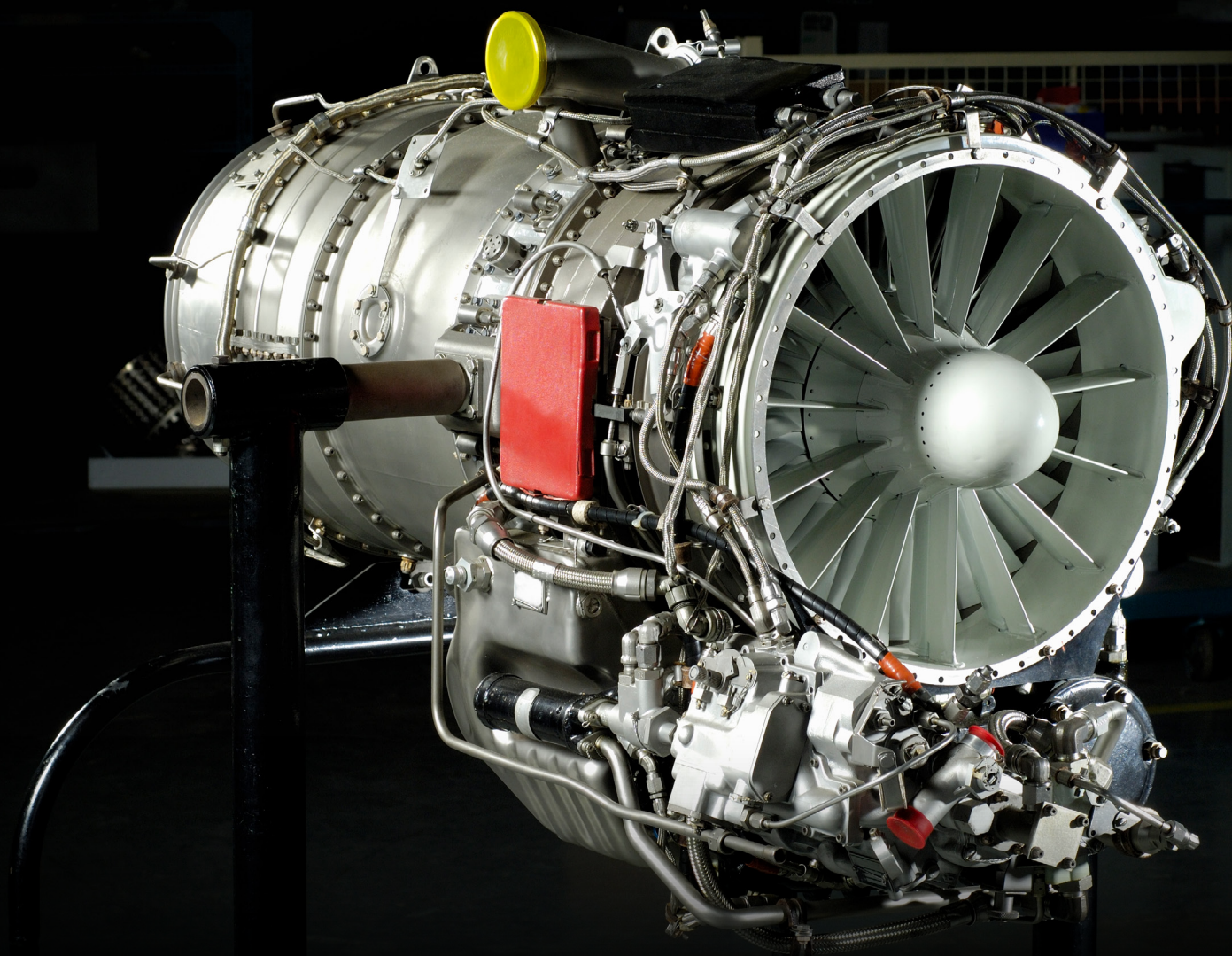


High
↑ Specific grinding energy
Low
↓

For this particular case, a sample from free cutting zone would reduce the likelihood of thermal damage and the sample from extended tool life zone can reduce excessive wheel wear.

High ← Wheel wear / surface roughness → Low

ABN and PremaDia solutions for aerospace manufacturing



Engine

Nickel-based alloys plated tools:

ABN300R & ABN900

Nickel-based alloys, vitrified bonded tools:

ABN800m & ABNS800

Titanium alloys and aluminides:

PDA999 & PDA989

Grinding of INCONEL® 718 case study



Challenge

INCONEL® 718, a nickel-based super alloy, has outstanding high temperature strength and oxidation resistance, suitable for harsh environments (e.g. aircraft turbines).

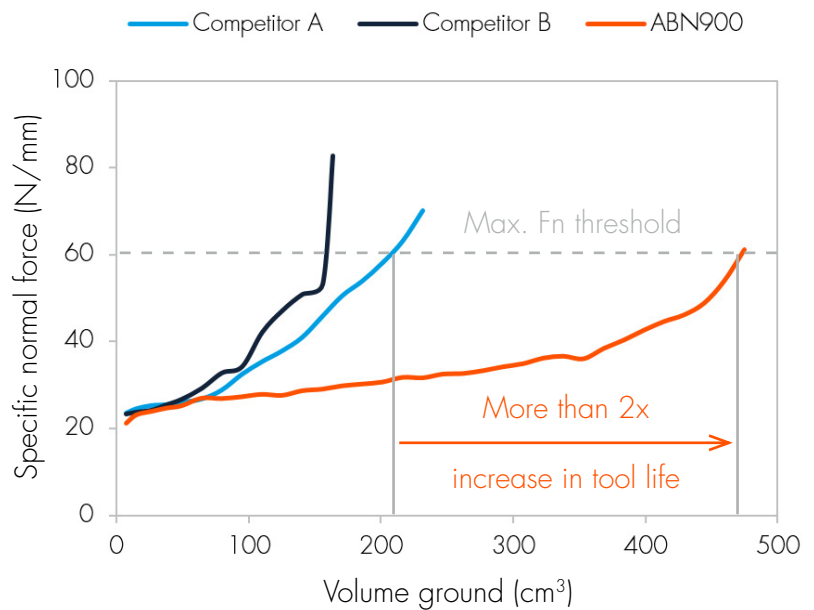
Adhesion, clogging, grit dulling and thermal damages are some of the challenges that can occur when grinding INCONEL® 718. Progress has been made over the years on how to tackle this 'difficult-to-grind' material however, still too often, a trial and error approach is being used to define the most suitable grit.

Solution: ABN900

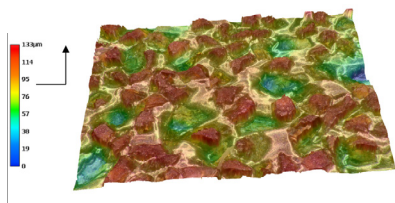
ABN900 has been designed with controlled inclusions, allowing the material to micro-chip and thus stay sharper for longer. This phenomenon results in reduced grinding forces and extended tool life.

Self-sharpening of grit enables:

- lower force generation (less contact between the wheel and the workpiece)
- less workpiece adhesion
- less heat generation

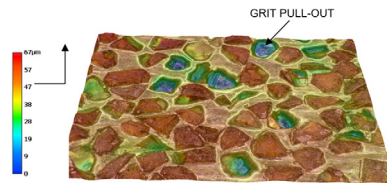


ABN900



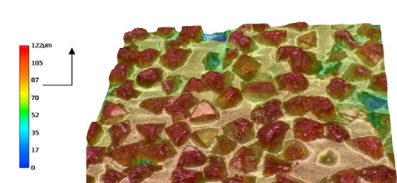
Microchipping leading to prolonged tool life

Competitor A



High abrasion wear leading to loss of grain protrusion

Competitor B



Grit dulling leading to increase of contact and higher risk of workpiece thermal damage



ABN and PremaDia solutions for tool making

Steel grinding

Resin bonded tools:

ABN200 & ABN200V

Vitrified bonded tools:

ABN200, ABN200V, ABN800 & ABNS800

Cermet & WC grinding

Resin bonded tools:

PDA433, PDA321, PDA311 & PDA211

Grinding of cermet material case study

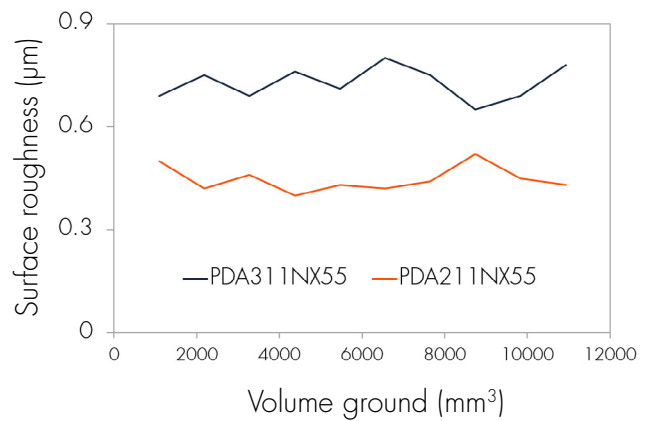
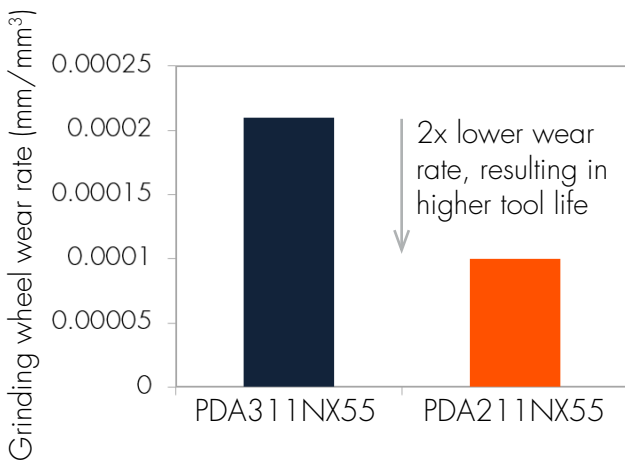
Challenge

Cermets are a well-known 'difficult-to-grind' material. They dull the grit and are prone to load onto the grinding wheel. These phenomena cause high specific grinding energy and lower wheel life. It has been proven that grit that is more friable is more suitable for this application because of its self-sharpening ability.



Solution: PDA21 1NX55

Using friable grit with micro-chipping ability allows self-sharpening, which results in lower grinding forces and longer tool life.



Micro-chipping of PDA211 under a lower load results in improved tool life and surface finish



Product offering: available sizes, coatings and claddings

Size availability

The sizing of all standard PremaDia and ABN products is carried out under strictly controlled conditions, in accordance with ANSI/FEPA international sieving specifications. Typically, they are available between 60/80 Mesh (252) to 325/400 (46), with the exception of ABN900, which extends to coarser sizes up to 30/35 (601). Other sizes can be supplied upon request. In the case of clad products, the size refers to the unclad particles.

ABN solutions	NX60	N60
ABN900	✓	
ABN800		✓
ABNS800	✓	
ABNX		✓
ABN300R	✓	
ABN200		✓
ABN200V	✓	

PremaDia solutions	TF	NX30	NX55	P60	C50
PDA999+	✓				
PDA999	✓				
PDA989	✓				
PDA878	✓				
PDA768					
PDA657			✓		
PDA466			✓		
PDA433			✓		
PDA321		✓	✓	✓	✓
PDA311		✓	✓	✓	✓
PDA211			✓		

Other coatings and claddings available upon request.



Element Six, part of the De Beers Group, designs, develops and produces synthetic diamond solutions and other supermaterials, and operates worldwide with manufacturing facilities in Germany, Ireland, South Africa, the UK and US.

Element Six solutions are used in applications such as cutting, grinding, drilling, shearing and polishing, while the extreme properties of synthetic diamond beyond hardness are opening up new applications in a wide array of industries such as optics, power transmission, water treatment, semiconductors and sensors.

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