

elementsix™

DE BEERS GROUP

Aero-Dianamics™ shaping productivity in aerospace

Advanced PCD round tool blanks
make new geometries possible
and break through barriers in
aerospace tool design

July 2020

The CFRP revolution

Revolutionary carbon fibre reinforced polymers (CFRP) composites and stacks drive airframe weight reduction



CFRP composites now make up 50% of airframe materials

For example, Boeing's 787 Dreamliner uses 50% by weight Carbon Fibre Reinforced Polymer (CFRP) composites for fuselage, wings, stabiliser, control surfaces and nacelles.

Transforming the economics of aircraft operations

The aerospace industry worldwide is switching to CFRP as airframe weight drives the economics of aircraft operations. CFRP enables a series of benefits including:

- Weight reduction for improved emissions and up to 25% greater fuel efficiency
- High durability for reduced maintenance costs
- High strength allowing higher cabin pressure for greater passenger comfort
- The opportunity to increase payloads

Meeting the challenge of machining new materials

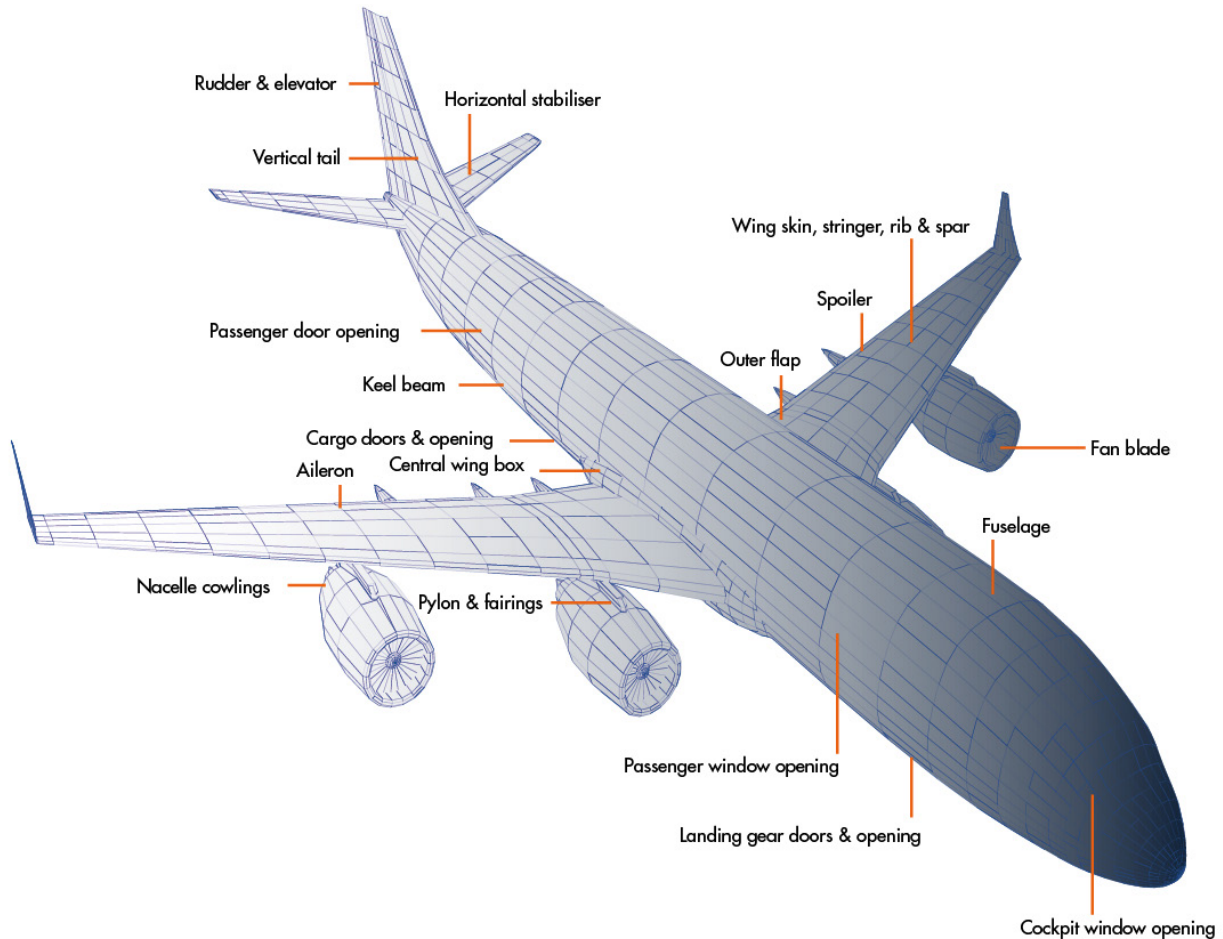
Machining these new strong, durable, lightweight and fibrous materials requires advanced technology, and the Aero-Dianamics™ range of polycrystalline (PCD) round tool blanks is designed to meet these machining challenges. Aero-Dianamics™ allows the tool designer to achieve previously impossible geometries that precisely match aerospace customers' milling and drilling applications.

PCD tools that accelerate production in CFRP

The ability to mill and drill CFRP faster, more cleanly, at lower temperatures and with lower tool forces means CFRP airframe components can be produced more efficiently and rapidly. In turn, that means finished components can be delivered for assembly with shorter lead times – allowing airplane manufacturers to deliver to customers on shorter schedules.

Tool design set free

Revolutionary PCD tool blanks break through barriers in aerospace tool design



About the Aero-Dianamics™ range

Tool designers can create entirely new PCD tool geometries, with:

- Freedom of design in flute profiles
- Multiple flutes
- Limitless flute angles and orientations (left/right/compressive)

These next generation composite tooling solutions entirely replace the need for coated tungsten carbide tools for fabricating composite components.

Main product portfolios

Element Six's Aero-Dianamics™ range has two portfolios, consisting of three production-ready product configurations.

AD-drilling



Chevron



Planar

AD-milling



Helix

Aero-Dianamics™ revolutionary drilling materials



Unique Planar AD3P blanks for complex drill geometries

- Almost infinite flexibility in drill point geometry
- Significantly increased wear resistance over traditional coated carbide drills
- Tool life more than 10* times longer than tungsten carbide drills
- Consistent performance over the tool life
- Greater cutting point flexibility
- PCD physically bonded to substrate, not brazed
- Superior work piece surface finish
- Large rake angles possible for lower tool forces
- Multiple re-sharpenings possible
- Fabrication by either electro-discharge machining (EDM) or conventional grinding
- Suitable for drilling CFRP stacked with aluminium and/or titanium

* The University of Birmingham, UK.



Premium quality Chevron A2DS PCD inserts for 2D geometry tools

- Full and half round disc formats
- EDM cut segments available to order
- Significantly increased wear resistance over coated carbide drills
- Tool life extended 10* times longer than carbide drills

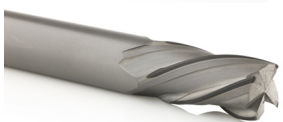
* The University of Birmingham, UK.



Revolutionary Helix A3MH blanks for milling tools

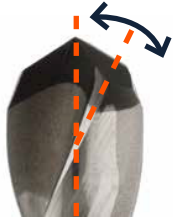
- Up to 250* times wear resistance compared with traditional tungsten carbide end mills
- Up to 12* times faster machining speeds
- Helical geometry results in lower tool forces and better chip evacuation
- High thermal conductivity and low coefficient of friction results in less heat build-up and adhesion
- Fast fabrication by EDM
- Sharp PCD edges cut fibres cleanly
- End mills can be reconditioned for even longer tool life

**Modern Machine Shop Magazine, USA.



Transforming PCD tool design

AD drilling



Helix cutting angle to cope with all application demands

- Flexibility to optimise design to meet work piece application demands

Cutting angle two



Dual angle drill point geometry

- Provides flexibility in determining drill cutting points
- Included angles up to 90° can be achieved



Multiple flutes

- More flutes result in lower forces, better chip evacuation and faster drilling speeds
- Tool designers not constrained by planar PCD shape
- Provides enhanced design flexibility
- Designers have ultimate choice of point angle, cutting lips, chisel edge or lip relief geometries
- Larger PCD layer formats remove the limitations associated with traditional planar PCD sections

AD milling



Pre-determined flute angle configurations

- Reduced PCD processing times
- Sharp PCD edges cut fibres cleanly
- More flutes result in increased cuts per rotation
- Helical geometry results in lower tool forces and better chip evacuation

Tools enabling increased levels of productivity

The five leaps in tool performance that deliver exponential increases in productivity

1 Superior wear resistance over coated tungsten carbide

PCD is the hardest man-made material in industrial use. Its wear resistance far exceeds that of tungsten carbide.

2 Longer tool life with consistent precision

The use of PCD extends tool life by a factor of at least 10* times compared to carbide. It maintains optimum sharpness throughout the life of the tool.

3 Flute angles that cut fibres more cleanly

PCD drills and end mills produce consistent hole and edge quality for significantly longer than coated carbide tools.

4 Faster tool operation with better temperature control

Tools can run faster with PCD as it has sharper edges and less friction, combined with excellent thermal conductivity. So CFRP stacks with aluminium and titanium can be drilled twice as fast** without the problems associated with the work piece overheating.

5 Reduced re-working and downtime

Long intervals between tool changes and the elimination of time-consuming reworking of holes and edges reduce machine downtime significantly.

* The University of Birmingham, UK.

** AMRC, Sheffield, UK.



The result is exponential increases in productivity

Revolutionary Aero-Dianamics™ tool blanks deliver productivity for tool makers by creating semi-finished tool materials and enabling fast fabrication.

They deliver productivity for aerospace customers by dramatically speeding up CFRP component production.

Delivering an attractive cost of ownership solution

Aero-Dianamics™ has been shown to be a proven cost effective solution for machining the latest generation of composite materials.

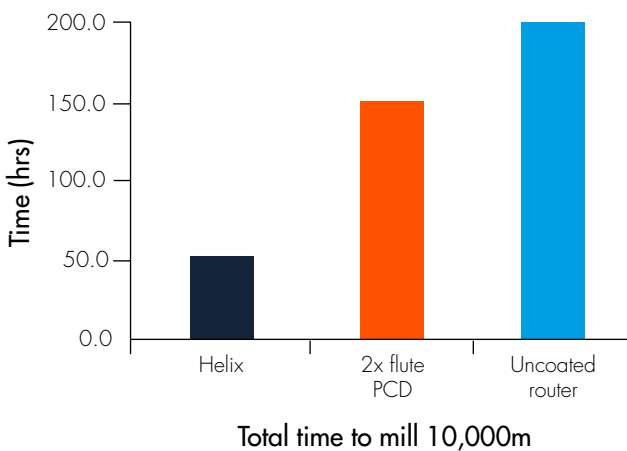
Representative examples are outlined below.

Results are taken from current testing, with further tests ongoing. More information available upon request.

Milling

Aero-Dianamics™ helix tools significantly reduce total time required to mill 10,000 metres compared to uncoated tungsten carbide and competitor flute PCD.

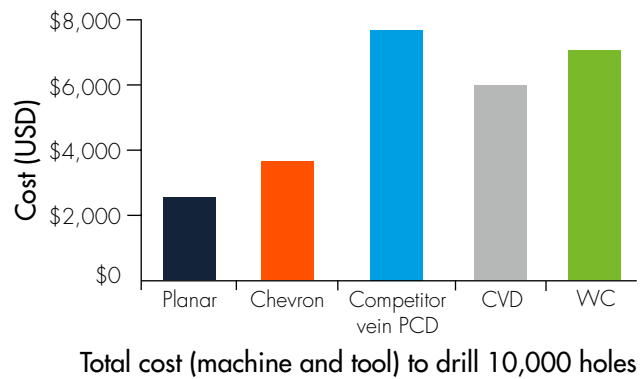
CFRP milling



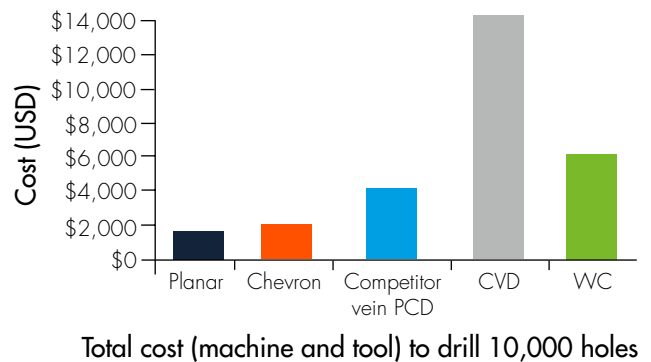
Drilling

Aero-Dianamics™ planar and chevron tools significantly reduce the total cost required to drill 10,000 holes compared to competitor veined PCD, chemical vapour deposition (CVD) and tungsten carbide tools.

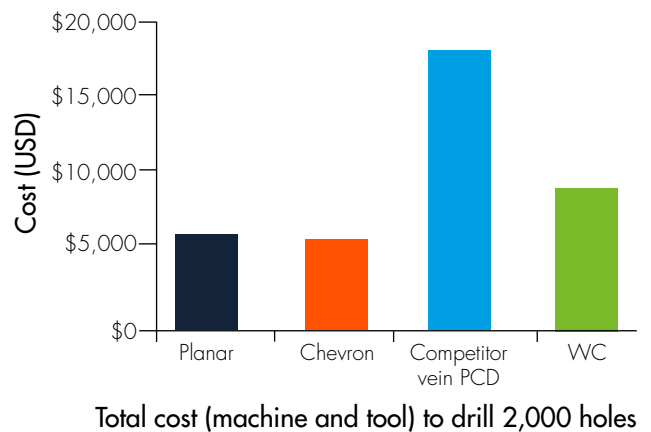
CFRP drilling



CFRP & AI drilling



CFRP & AI + TI drilling



elementsix™

DE BEERS GROUP

Element Six is a global leader in the design, development and production of synthetic diamond and tungsten carbide supermaterials. Part of the De Beers Group, we employ over 1,900 people. Our primary manufacturing sites are located in the UK, Ireland, Germany, South Africa, and the US.

Element Six supermaterials solutions are used in a wide range of applications across multiple industries, including manufacturing in the Automotive and Consumer Electronics industries, cutting and drilling in the Oil & Gas industry, and in components for Mining, Road & Wear applications.

Element Six uses the extreme properties of synthetic diamond to open up new possibilities in areas such as quantum optics, acoustics, power transmission, water treatment, thermal management and sensors.

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