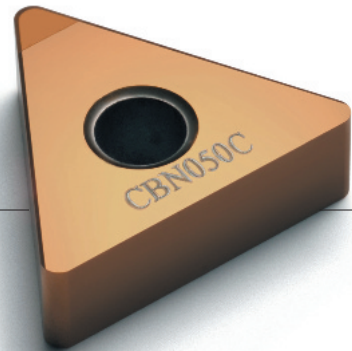


# Exotic substrates



**Ceramics, PCBN, PCD, CBN and cermets. SteedWebzell examines the world of exotic cutting tool substrate materials**

**C**eramics, PCBN, PCD, CBN, cermets can provide genuine machining advantages over conventional carbide grades, provided they are applied correctly (see box item, page 40).

So what's hot and what's not? Of course everyone has their own opinions on this, with cutting tool suppliers focusing on those areas where most gains can be made.

## CERAMIC NICHE

For instance, according to WNT, ceramic cutting materials will remain as niche products with a relatively narrow application area such as automotive. "We are finding that the development of carbides is diminishing the advantages that ceramics once had," says the company's business development manager, Adrian Fitts. "This is compounded by the time required to develop the practical functionality of ceramic materials, an area that depends, to a much greater extent than carbide, on detailed knowledge."

However, WNT predicts that PCBN and CBN will have a bigger role to play in metalcutting due to their sandwich method of manufacture. This allows inserts to be pressed on both sides, simplifying the manufacturing process considerably. That said, as with ceramics, the major problem with boron nitride is the correct

*Right – ITC's 2111 two-flute PCD endmill is targeted at abrasive non-ferrous materials used in the motorsport sector. Above – Seco's CBN050C, claimed as the world's first multi-format PCBN grade*

application of the insert.

Finally, the development of PCD has seen WNT introduce PCD inserts with chipbreakers for use in non-ferrous and difficult-to-machine material applications. The design of the new chipbreakers ensures high levels of chip control, particularly on the newer aluminium materials – for example, very soft, low quality, difficult-to-machine aluminium such as HE30. However, this development is not to the detriment of the conventional advantages of PCD tooling, such as "no burr" and long tool life.

Confirming the predictions of WNT, Jacob Harpaz, president of the IMC Group (which includes Iscar, Ingersoll and TaeguTec) also says that the global use of cutting tools is changing in terms of tooling materials. "Between 2000 and 2005, the global market for PCD usage increased from \$230 to \$460 million, prompted by overwhelming growth in the automotive sector and the use of cast iron and hard ferrous materials in this industry," he says. "This growth is also reflected by CBN usage rising from \$190 to \$380 million."

## THE PCBN FACTOR

Since the mid-1980s, PCBN cutting tools have gained rapid acceptance in the automotive industry. Having long tool life and the capability of operating at high cutting speeds, PCBN cutting tools have helped automotive companies increase capacity on existing equipment while improving workpiece quality.

The cubic boron nitride crystal's high hardness, thermal stability and chemical inertness provide an extremely efficient cutting tool. Generally speaking, PCBN machining operations should be run dry. PCBN is hard enough to resist deformation from the heat generated in machining, but it is also brittle enough to crack from the thermal shock of coolant. That is especially true in the case of interrupted cuts – never use

### Which for what?

**Ceramics** – Typical applications include general machining of cast iron, heat resistant alloys and hard materials up to 65 HRc, as well as semi-finish and finish machining of ductile cast iron and high speed machining of cast iron. Ceramics can achieve high metal removal rates and so are well suited to large components such as cast iron truck hubs, turbine shafts and steel mill processing rolls.

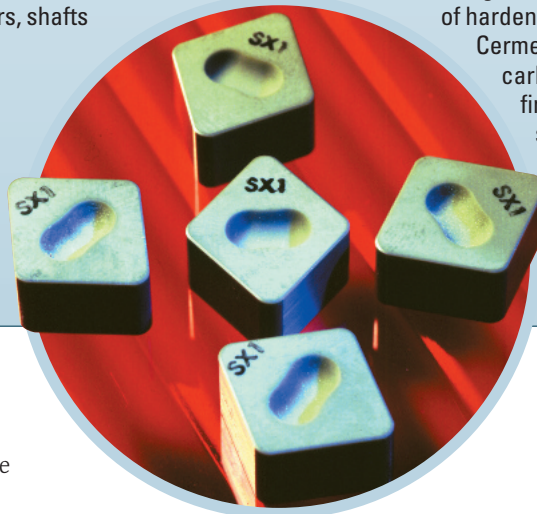
**PCBN (polycrystalline cubic boron nitride)** – Most associate PCBN with the machining of hardened steel parts (above 45 HRc) or superalloy components in the automotive industry, such as the rough boring of cylinder liners or the turning of engine parts such as gears, shafts and bearings. However, it is also economical to use this substrate material to machine cobalt or iron-based powdered metals, as well as difficult cast iron alloys previously processed exclusively by grinding.

**PCD (polycrystalline diamond)** – Typical uses include face milling of aluminium alloys and other non-

ferrous materials where high chip resistance is required. It is also used for medium-high silicon-aluminium alloys where tools need to display abrasion resistance. Many automotive components benefit from this grade of cutting tool including cylinder heads, rocker shafts, transfer cases, intake manifolds and oil pump bodies. Optimised cutting conditions would typically be in the region of 12,500 rpm spindle speed at 0.1 mm per tooth feed.

**CBN (cubic boron nitride)** – Suited to high depths of cut in cast iron machining, high speed machining of cast iron, hard machining of roll forms, as well as milling and turning of hardened steel and sintered hard materials.

**Cermets (hybrid ceramic and metal carbides)** – Typical applications include finish and semi-finish machining of steels, ductile iron and sintered alloys, bearing race machining, and high speed finish machining of ductile steels. It is also well suited to grooving stainless steels and nodular irons.



coolant in PCBN operations where the cut will be interrupted.

One all-new PCBN grade is CBN050C, which Seco is declaring to be the world's first multi-format PCBN grade – available in solid, full-faced, multi-tipped and single-tipped formats. Seco has also introduced CBN400C, another new PCBN grade for machining grey cast iron and abrasive steel components used extensively in the automotive sector, such as engine blocks, cylinder heads, valve seats, valve stems, fuel injector nozzles, fuel pump barrels, crankshafts, camshafts, transmission casings, gears and shafts, as well as brake discs, brake drums, clutch plates, clutch sleeves, axle casings, CV joints and other powertrain components.

Seco says that its PCBN tooling offers a 10-fold increase in cutting speed and a 100 per cent increase in feed rate when face milling grey cast iron engine blocks in comparison with tungsten carbide tools. Surface finish and flatness are also improved – essential in relation to the head gasket sealing surface.

But exotics are not all about the automotive sector, as proved by NTK Cutting Tools, which has many years' experience in delivering various cutting tool solutions, and now offers a selection of exotic tooling substrates for the aerospace industry. The company's new WA1, for example, is a whisker-reinforced ceramic grade developed by adding silicon carbide to alumina. It offers extreme fracture toughness and notch resistance for applications required typically in the aerospace sector.

NTK has also just launched its new SX1 silicon nitride ceramic grade for cast iron machining (pictured, left). It has been developed to reduce the notch wear of ceramic in heavy roughing operations and can function at high operating speeds under dry cutting conditions. This is enabled by the

reduction of a binder element in the substrate – effectively a change from an inter-granular phase of silicon nitride particles to a higher melting point compound.

### ABRASIVE TARGETS

Closely allied to aerospace is the UK's buoyant motorsport sector and it is here that ITC has enjoyed considerable recent success. Its new 2111, 2102 and the 4081 series of endmills are targeted at the machining of graphite, metal matrix composites, Kevlar, carbon fibre and other abrasive materials used commonly in the motorsport industry.

The 2111 series is a high performance two-flute PCD endmill with a solid carbide shank and necking for extra reach. Similar to the 2111, the 2102 series has a solid carbide shank with PCD brazed tips for enhanced tool life and productivity when machining carbon fibre parts.□

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