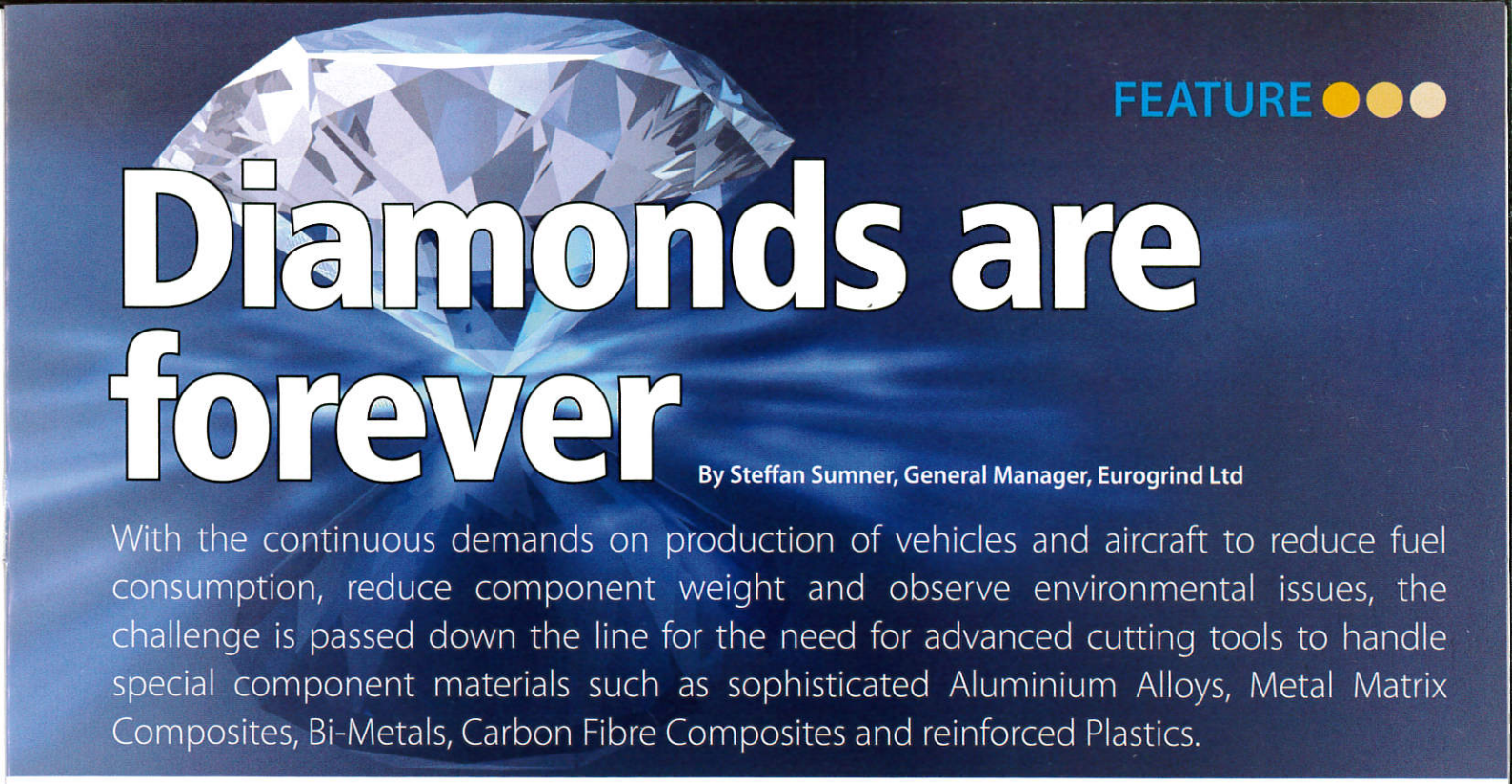

Diamonds are forever

By Steffan Sumner, General Manager, Eurogrind Ltd

With the continuous demands on production of vehicles and aircraft to reduce fuel consumption, reduce component weight and observe environmental issues, the challenge is passed down the line for the need for advanced cutting tools to handle special component materials such as sophisticated Aluminium Alloys, Metal Matrix Composites, Bi-Metals, Carbon Fibre Composites and reinforced Plastics.

Developed as a cutting material in the mid 1950's Polycrystalline Diamond (PCD) has become the leading provider of cutting tool solutions for the machining of advanced materials. Best applied on dedicated machines doing the same thing day in and day out, it offers a much longer tool life than other cutting materials, making it an effective way to reduce downtime caused by tooling changes. And less downtime means reduced production costs.

Diamond is a pure carbon, found in two forms; graphite and diamond. In diamond, the carbon atoms are arranged in an isometric, or cubic, crystal arrangement and it is this unique arrangement that makes diamond the hardest material.

Produced on a cemented carbide substrate under extreme pressures and temperatures, during the process the cobalt from the cemented carbide substrate infiltrates through a layer of synthetic diamond powder (laboratory-created diamond), causing neighbouring grains to grow together. Only a small residue of cobalt is required to provide significant toughening, and the bonded carbide substrate allows the composite to be brazed to any tool, allowing the expensive PCD material to be located only where it is used for cutting.

Whilst PCD is extremely fragile, it has superior resistance to abrasion and is used where abrasive materials would wear anything else down. Recent experimentation suggests that with specific edge preparations and cutting conditions, it is possible to machine other materials such as titanium alloys, tungsten carbides, ceramics, bi-metal materials of aluminium and grey cast iron and reinforced plastics.

With Polycrystalline Diamond, there are a number of machining characteristics.

Aluminium alloys

There are many aluminium alloys on the market with the most well known being the 2000 series and the 6000 series for use in the automotive and aerospace industries. With PCD, cutting speeds can be 3 to 4 times higher than is possible with tungsten carbide, giving, potentially, hundreds of times the tool life of tungsten carbide.

Metal Matrix Composites (MMC)

The most common base material for MMC is aluminium. A ceramic reinforcement is added to this base material (most commonly Si) and this material is replacing heavier materials like cast iron in vehicle parts like cylinder blocks and brake discs. The cutting speed required for this type of material needs to be adapted to the ceramic content, for example, the higher the abrasiveness, the lower the cutting speed needs to be to protect the cutting edge.

Bi-metal

Machining bi-metal components creates a challenge for the tool. A tool material that works well on one of the metals may not be so efficient on the other. Under the correct parameters a solution can be found with PCD.

Carbon Fibres Composites

With the objective of improving the power to weight ratio of vehicles and aircraft, the most common composite is CFRP (Carbon Fibres Reinforced Plastics). Cutting conditions must balance the risk of flaking the work piece fibres and that of chipping the cutting edge.

Plastics and Reinforced Plastics

PCD tools are particularly effective on abrasive plastics where plastics are reinforced with carbon fibres or glass fibres.

Graphite

Most of the machining is done in the production of synthetic graphite electrodes. Graphite is soft but very abrasive, however, at a cutting speed of 1,000m/min, toll life of PCD tooling is unbeatable.

As for the question about PCD tooling being expensive, especially bespoke designs, it is important to understand that they can be refurbished reasonably inexpensively. For example, heavily worn PCD cutting edges can be replaced on the original tool body and slightly worn cutting edges can often be reground. This refurbishment usually returns the tool to its original condition at a reasonably low cost compared to a new tool.