

When the toughest jobs demand tough solutions: Diamond coatings make the difference!

The increasing demand for lighter yet more robust materials is driving a growing need for tools that can machine these materials effectively. Efficient machining of materials such as CFRP, ceramics, graphite, and aluminum compounds requires high tool service life and process reliability – and diamond coatings offer an ideal solution for these materials. Although they are complex and time-consuming to produce, diamond coatings significantly reduce abrasive wear and greatly enhance productivity. Extremely hard and wear-resistant diamond coatings are indispensable, particularly in the automotive, aerospace, tool and mold making, and medical technology industries.

Compared to PVD coatings (approximately 40 GPa), PACVD/CVD diamond coatings stand out with their unrivaled hardness of approximately 80-100 GPa. They are not only more resistant to wear, but also possess high thermal conductivity and are nearly chemically inert. Diamond coatings allow challenging materials to be machined, such as those used in dental prosthetics and aircraft construction, and can significantly reduce production costs, as two impressive examples demonstrate.

Focus on zirconium oxide: Diamond gives dental technology the perfect finish

Machining zirconium oxide in dental technology is a challenging task, especially when using micro-milling tools with diameters ranging from 0.1 to 1 millimeter and working with minimal manufacturing tolerances. With advanced diamond coatings from Oerlikon Balzers' BALDIA portfolio, dental labs can significantly reduce tool wear and associated production costs. These coatings enable precise manufacturing tolerances in tool diameter and coating thickness, which are critical for machining highly abrasive materials like zirconium oxide. The extreme hardness of the BALDIA coatings greatly extends tool service life while simultaneously reducing friction and excessively high heat load. These properties allowed the dental lab [Ziacom Medical](#) from Spain to achieve excellent surface quality even at higher cutting speeds, ensuring the best possible dental care for its patients.

CFRP makes aircraft lighter but poses challenges in machining

Fiber-reinforced composites like CFRP are revolutionizing aircraft construction with their lightweight properties but machining them poses significant challenges. Two models from the best-known aircraft manufacturers already use CFRP for 30 to 50 percent of their structure, making cost-effective machining of carbon fiber-reinforced plastics a major issue. For precision drilling in CFRP, which must penetrate materials 11 to 25 millimeters (0.43 to 0.98 in) thick with tight tolerances of just a few tens of micrometers, specialized tools are essential.

C6 Composite Tooling, based in the German state of Baden-Württemberg, offers customized solutions to meet these demands in the aerospace industry. The manufacturer worked with Oerlikon Balzers to optimize the machining process, and using a BALDIA diamond coating significantly improved the service life of the one-shot drill from 80 to over 250 holes. This solution reduced tool costs by more than half and greatly increased the cost-effectiveness of drilling.

Andreas Mayer, Engineer Automation Technology at FACC, confirms the success: “The tool and coating perform well in all applications, whether on semi-automatic drill feed units or on CNC machines. We’re particularly pleased with the high cost-effectiveness of drilling, as well as the reduced tool changeover and down times, which are our main targets.”

As precise as a Swiss watch

In the demanding world of watchmaking, machining platinum alloys presents a unique challenge that requires maximum precision. Oerlikon Balzers provides tailored diamond coatings for this purpose. These coatings not only enable precise machining with tight tolerances but also ensure long tool service life and optimum process reliability.

The diamond coating process: complex and time-consuming

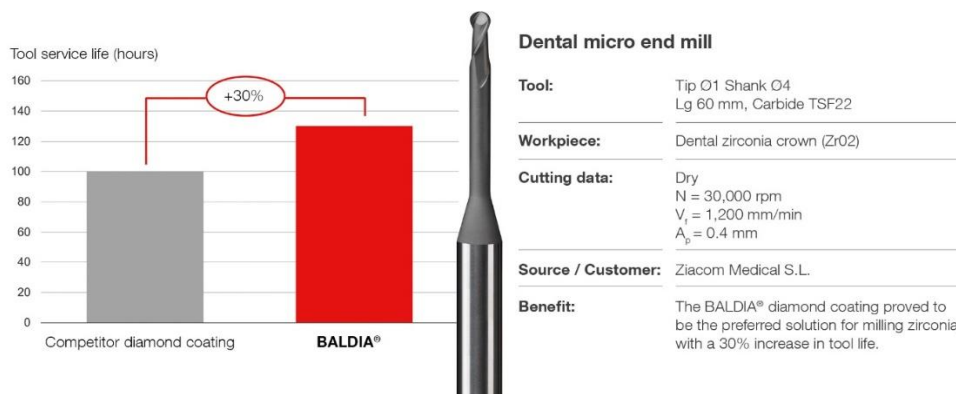
The process of producing diamond coatings is complex and time-consuming, requiring precision at multiple stages to achieve the best possible results. The first step is to thoroughly clean and analyze the tool surfaces (substrates) before chemical pretreatment. The next stage, developed by Oerlikon Balzers, is crucial and lays the foundations for the successful growth of diamond crystals.

“By precisely controlling interruptions in the growth process, we can adjust the size of the crystals to create either micro- or nanocrystalline structures, tailored to the specific requirements of each application,” explains Matthieu Guillon, Product Manager for Diamond Coatings at Oerlikon. He also highlights the ongoing development of customized carbon coatings: “The close collaboration between Oerlikon Balzers and D-Coat and our extensive expertise have enabled us to consistently develop innovative coating solutions specifically designed for demanding machining applications. They ensure economical processing of highly abrasive special materials and significantly extend the tool service life of our customers’ machining tools. Although the production stages for our diamond coatings are complex and take time, quality is our number one priority.”



(Image: Oerlikon Balzers)

Carbon fiber-reinforced plastics (CFRP) are lightweight and robust but machining them efficiently poses a significant challenge. Diamond coatings offer an ideal solution, though for some applications they must meet very tight drilling tolerances, which are carefully examined in the lab.



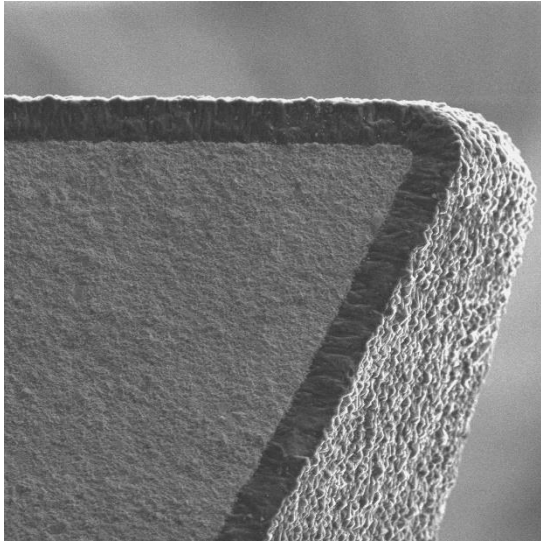
(Image: Oerlikon Balzers)

Many dentists and dental labs rely on diamond coatings for the production of dental implants. In this case, the BALDIA® diamond coating proved to be the preferred solution for milling zirconium oxide, increasing the service life of a Spanish dental lab's tools by 30 percent.



(Image: FACC)

From 80 to 250 holes: A BALDIA diamond coating significantly improved the service life of a one-shot drill used to machine CFRP in aircraft construction, reducing tool costs by more than half.



(Image: Oerlikon Balzers)

A BALDIA diamond coating under the scanning electron microscope (SEM): The cutting edge of the machining tool shows the uniform coating thickness distribution. This is crucial when minimal tolerances and optimum performance are required.

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With its technology brands – Oerlikon Balzers, Oerlikon Metco and Oerlikon AM – the Oerlikon Surface Solutions division focuses on technologies and services that improve and maximize performance, function, design, reliability and sustainability, which are innovative, game-changing advantages for customers in the automotive, aviation, tooling and general industries and in the luxury, medical, semiconductors, power generation and oil & gas markets.

The division is part of the publicly listed Oerlikon Group (SIX: OERL), headquartered in Switzerland, which has more than 12 600 employees and generated CHF 2.7 billion in revenue in 2023.