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## AN UNRIVALLED COMBINATION OF LIGHTNESS AND STRENGTH

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For the very first time, IWC Schaffhausen has manufactured a watch case from a ceramic matrix composite (CMC). The company developed the complex manufacturing process in collaboration with the German Aerospace Center (DLR). Lorenz Brunner, Department Manager for Research and Innovation at IWC, looks back on an engineering journey that lasted almost a decade.

Lorenz Brunner, what category do CMC materials belong to?

CMC stands for “ceramic matrix composites”. These are composite materials consisting of fibres embedded in a matrix. Unlike in conventional carbon-fibre-reinforced polymers, the matrix is not made from polymer but rather ceramic.

What are the characteristics of these materials?

On the one hand, ceramic matrix composites have the typical properties of ceramics – they are very hard, scratch-resistant and corrosion-resistant. On the other hand, unlike a conventional ceramic body consisting of sintered particles, CMC components are significantly lighter and not brittle.

Why are they so incredibly resistant to damage?

As with any composite, the desired material properties are the result of the interactions between the two main components – in this case, the ceramic matrix and the embedded fibres. If the CMC component is subjected to an impact, there will still be a crack in the matrix. But the energy from the crack will be absorbed by the fibres, diverted and then distributed in the fibre bundle.

In which applications are these materials already being used?

Thanks to their unique properties, ceramic matrix composites are ideal for applications with extremely high requirements regarding strength, lightness and temperature resistance – including in aerospace. CMC materials are also often used for making brake discs for sports cars and luxury cars.

IWC developed the new material in partnership with the German Aerospace Center. How did this come about?

Manufacturing CMC components requires very in-depth and specific technical know-how. When we were looking for a partner, we came across the DLR (German Aerospace Center). It has comprehensive expertise in this field and was able to provide us with specialist support in developing the material.

How exactly does a CMC watch case take shape?

The starting point is a conventional carbon-fibre-reinforced polymer. You cut up carbon fibres, infiltrate them with a resin, press them into a mould and bake them. This pressing process produces a preform in the approximate shape of the watch case, which is slightly oversized all round.

But now we only have a part made from carbon-fibre-reinforced polymer.

Yes, that is right. The next step is to remove the polymer matrix. This is done by a process called pyrolysis. To do this, the preform is heated in an oven to a temperature above the decomposition temperature of the polymer matrix. During this process, which takes about seven days, the polymer converts to carbon. Due to the fact that the carbon fibres are thermally stable, only the matrix is converted. This leaves us with a dense weave of fibres that are embedded in a porous carbon matrix.

**And how do we incorporate the ceramic matrix?**

This adds another step to the process – siliconisation. Silicon crystals are placed on the component, which currently only consists of carbon fibres and the carbon matrix. Together, they are then heated in an oven above the melting point of silicon, so that silicon is pulled into the cavities by means of capillary forces. During this process, silicon – which is, of course, a semi-metal – reacts chemically with the carbon matrix and a portion of the fibres. As a result, a matrix made of silicon carbide ceramic is formed in the cavities between the fibres.

**Is the watch case already finished now?**

After siliconisation, the case is still slightly oversized and features a metallic surface that needs to be removed. Given that silicon carbide ceramic already has a hardness of around 2400 Vickers, from this stage onward the case can only be ground using diamond tools. This is a very painstaking process.

**Why did it take almost a decade to develop this process?**

The manufacturing process for ceramic matrix composites is very complex and time-consuming. We had to answer countless detailed questions – from selecting the raw materials for the fibres and matrix to determining the exact process parameters for the individual steps. To ensure perfect quality, we also carried out computer tomography analyses, among other measures. This helped us to ensure, for example, that there were no pores or cracks in critical areas and that the fibres were evenly distributed.

**What were the biggest challenges?**

Nobody has ever produced a watch case from a ceramic matrix composite before. Therefore, we first needed to learn how the material behaves in this application. The pyrolysis and siliconisation processes need to work perfectly for an evenly distributed ceramic matrix to form in the entire component. During the development process, we also had to make some adjustments to the geometry in order to take full advantage of the material's benefits.

**What does the finished watch case look like?**

The finished cases are matte black and exhibit a structure that is determined by the fibres, which is different in every single piece. The cases are not just feather-light, hard and scratch-resistant, they are also more damage-resistant than conventional ceramics. But the hard work was well worth it. By developing the first watch cases made from a ceramic matrix composite, we are once again underscoring IWC's pioneering role when it comes to using new materials.

## IWC SCHAFFHAUSEN

IWC Schaffhausen is a leading Swiss luxury watch manufacturer based in Schaffhausen in the north-eastern part of Switzerland. With collections like the Portugieser and the Pilot's Watches, the brand covers the whole spectrum from elegant to sports watches. Founded in 1868 by the American watchmaker and engineer Florentine Ariosto Jones, IWC is known for its unique engineering approach to watchmaking, combining the best of human craftsmanship and creativity with cutting-edge technology and processes.

Over its more than 150-year history, IWC has earned a reputation for creating professional instrument watches and functional complications, especially chronographs and calendars, which are ingenious, robust, and easy for customers to use. A pioneer in the use of titanium and ceramics, IWC today specialises in highly engineered watch cases manufactured from advanced materials, such as coloured ceramics, Ceratanium®, and titanium aluminide.

A leader in sustainable luxury watchmaking, IWC sources materials responsibly and takes action to minimise its impact on the environment. Along the pillars of transparency, circularity, and responsibility, the brand crafts timepieces built to last for generations and continuously improves every element of how it manufactures, distributes, and services its products in the most responsible way. IWC also partners with organisations that work globally to support children and young people.

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