Some Like It (Very) Hot

Silicon carbide, carbon fiber, or magnesium ceramics—a Porsche is far more than the sum of its steel and aluminum parts. For the materials experts in Weissach, the pursuit of the perfect material for each and every component never ends.

By Johannes Winterhagen **Photos by** Bettina Keidel

RAW MATERIALS:
Carbon fibers and silicon for a brake disc

END PRODUCT:
Ceramic brake disc of a 911 GT3 RS (997)

A *few black flakes, light as a feather,* and a silvery powder. A strip but less than few millimeters wide that looks just right for wrapping gifts. A metallic granulate. And these can be transformed into a Porsche? Well, not an entire Porsche, of course, but certain critical components: a brake disc, a front hood, a convertible top.

At first glance, a cake from the hands of a master pastry chef may not reveal the exquisite ingredients that went into creating it. And yet weeks or even months may pass until every detail of the recipe is right. At Porsche, the materials experts working together with components developers take a similar approach. “Our goal is to find the right material and manufacturing process for each component,” explains Dr. Robert Volz, head of the material technology pre-development division in Weissach. A small but effective team of material technology specialists assists the development engineers in the selection of materials.

Let’s start with the black flakes. These are pure carbon, drawn into fibers, coated, and then reduced to a length of nine millimeters. Together with a few other ingredients—which shall remain secret, just as in the world’s finest pastries—these fibers are processed into a composite paste and charged into a mold. During the next stage of this injection molding process, the paste is hardened under pressure at a temperature of 200 degrees Celsius. At the end of this process, even a layperson can see what is being produced: a brake disc.

The brake discs now make a stop at a second kiln. A nitrogen atmosphere and a temperature of 900 degrees Celsius produce a high-tensile carbon disc that next undergoes mechanical processing: positioning the holes for ventilation and water dispersal. It is now time for silicon—obtained from sand and now in liquid form—to step on stage. The carbon absorbs it as eagerly as a sponge absorbs water. This is because, although the component gives the impression of being completely seamless, in fact it incorporates millions of tiny capillaries located between the interlocking fiber snippets.

The disc then heads back to the kiln, this time into a temperature of over 1,400 degrees Celsius (the temperature of the

RAW MATERIAL:
Coil with carbon
fibers for a front hood

END PRODUCT:
Carbon front hood
of a 911 GT2 RS

visible outer layer of the sun, the photosphere, is over 6,000 degrees Celsius). The silicon reacts with the surfaces of the fiber snippets, creating a silicon carbide ceramic. The result is a brake disc that combines ceramics' high thermal resistance and resistance to wear with the mechanical stability of carbon fibers—a brake disc that can handle its 73rd curve on the Nurbürgring as though it were its first. High-performance cast iron brakes are not necessarily inferior, but if it is necessary to brake harder, the driver must step more firmly on the brake pedal. However, the main advantage is in the reduced weight: ceramic brake discs are 50 percent lighter.

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Carbon fiber reinforced plastics (CFRP) marry extreme stability to a very low weight. A super lightweight construction, as will be used in the 918 Spyder, is the ideal home for a material that earned its wings in motor sports. But more and more often, CFRP is also used in roadworthy race cars such as the 911 GT2 RS. Take the front hood, for instance, which weighs over two kilos less than its aluminum cousin on the basic vehicle. During production of the hood, the fibers are not reduced in diameter, but rather interwoven into a mesh and saturated with a plastic resin. Several layers of the impregnated mesh are cut out by hand, inserted in a mold, and then baked under pressure and at a high temperature in an autoclave, which could be described as a type of pressure cooker. Several hours later, the component is sufficiently hardened to permit it to be abraded and varnished.

Thinking ahead to future CFRP applications, Porsche engineers are working on new, time-saving processes. For example, take a look at the monocoque construction of the 918 Spyder, which employs the principle of resin transfer molding (RTM). In this process, the interwoven carbon fiber mesh is placed in a mold, resin is injected into the fiber pack, and the composite is then cured for about 20 minutes.

The right material at the right spot also means that the further apart it is from the vehicle's center of gravity, the more important it is to keep its construction as light as possible—at least in a sports car, where agility is of the essence.

RAW MATERIAL:
Magnesium chips for parts of a convertible roof

END PRODUCT:
Convertible roof of the 911Carrera (991), with magnesium bows

So it's no wonder that Porsche decided on a magnesium roof support structure for the new 911 Cabriolet. This light alloy is four-and-a-half times lighter than iron. Tried-and-true pressure casting technology is used for the wide panel bows that add stability to the soft top of the 911—something one would usually only expect to see in a folding hardtop. In this process, magnesium pig iron is melted down; the hot molten mass, to which small quantities of other ingredients are added, is poured into a mold. It is then subjected to high processing pressure and sets in the desired shape. A process known as thixomolding is now used for one part of the roof struts, which connect the bows with one another. In this process, the magnesium is in a thixotropic, or semi-solid, state. In its dough-like form, it is pressed into a worm screw, where it cools until it has hardened. In comparison with pressure casting, fewer air pockets form when this process is used. And that means slimmed-down, weight-saving bows.

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At 36 kilos, the new convertible top of the 911 Cabriolet may not be much trimmer than its excellent predecessor, but in terms of acoustics and long-term stability, it clearly surpasses it. This all adds up to "more function per pound." Cars that do more without weighing more—in Weissach, that's not a hopeful future vision, but Porsche reality today. ●

911 CARRERA CABRIOLET (TYPE 991) **Engine:** Six-cylinder boxer, **Displacement:** 3,436 cc, **Power:** 350 hp (257 kW), **Maximum torque:** 390 Nm at 5,600 rpm, **0–100 km/h:** 5.0 (4.8*) sec., **Top track speed:** 286 (284*) km/h (178/176* mph), **CO_2 emissions:** 217 (198*) g/km, **Fuel consumption** City: 13.1 (11.4*) l/100 km, Highway: 7.0 (6.7*) l/100 km, Combined: 9.2 (8.4*) l/100 km. * with Porsche double-clutch transmission (PDK)