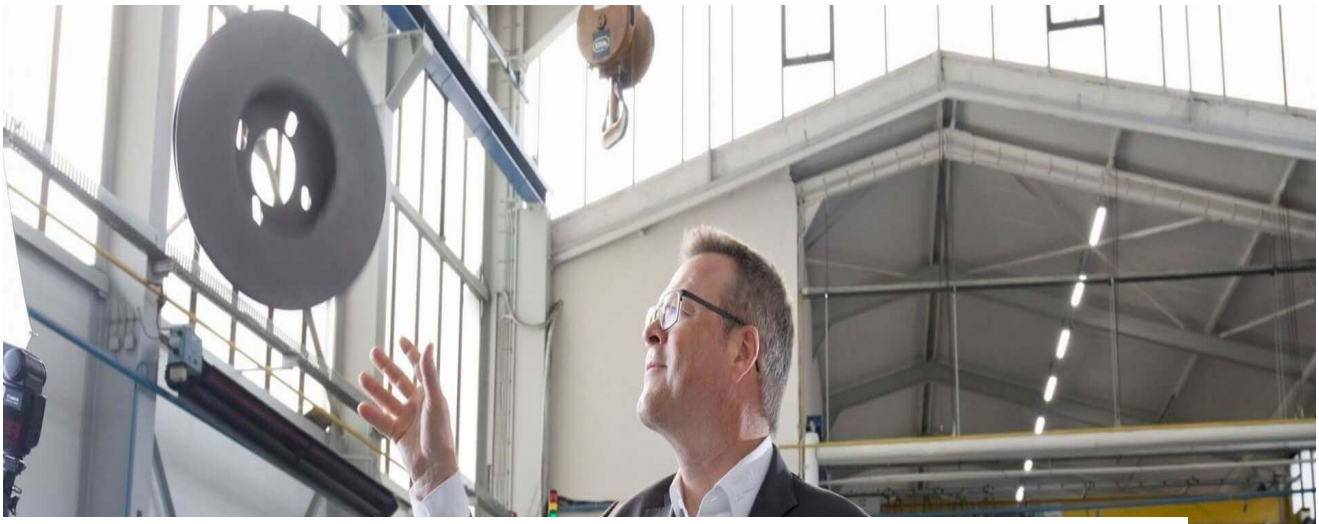


GABRIEL PANKOW

Euro 7 standard: TRUMPF laser reduces fine dust

Europe is phasing out conventional brakes as they generate excessive fine dust, so anyone seeking to sell vehicles on the continent must now find an alternative. Nagel's machine laser-coats brake disks for near-zero wear, with two beam-shaping methods enhancing the process.

Most of the dirt does not come from the exhaust. Up to 70% of fine dust is produced when driving due to particle abrasion from tyres, road surfaces and brakes, even on electric cars. The EU Environment Agency (EEA) estimates that around 250,000 Europeans die prematurely every year due to excessive fine dust pollution. Until now, the European Union has regulated only the exhaust emissions of petrol and diesel vehicles via the Euro standards. With the launch of the Euro 7 standard, it is now taking on the tyres and brakes on all cars. Automakers intending to sell new vehicles in the EU after 2026 – which includes all major manufacturers – must now quickly develop solutions to reduce abrasion by 80%.

Tough nut to crack

Dr Claus-Ulrich Lott is CEO of Nagel Maschinen- und Werkzeugfabrik GmbH in Nürtingen. As he walks through the older, brightly lit area of the main building, he ponders: "What does the ideal solution look like? Firstly, it must comply with the standard. Which means virtually no abrasion. That is indisputable. Secondly, it must be affordable. Brakes are a mass-produced product, so the unit price is a matter of cents. And thirdly, it has to fit into the established production sequence with as little disruption as possible." Lott pauses in front of the brake disk production testing facility. "That's why we decided to build a machine that applies an ultra-hard coating to brake disks."

> **"The cost-effectiveness of coating relies on obtaining the desired outcome while keeping powder use to a minimum."**
>
> Claus-Ulrich Lott, CEO of Maschinen- und Werkzeugfabrik GmbH

A cast-iron car brake disk rotates under a laser optic and seven powder feed nozzles on the machine rotary table. The high-speed laser deposition welding cell, called NaCoat, applies two layers. First of all, a 0.1-millimetre-thick adhesive layer made of stainless steel, which is then topped with a 0.2-millimetre-thick functional layer studded with ultra-hard carbide particles. "After thirty seconds of processing, the surface appears under the microscope like a chocolate bar with whole nuts – the hard particles visibly protrude," Lott explains. "This step, however, would not yet lead to a decrease in fine dust."

The brake disk is inserted into the NaGrind grinding machine, which uses 36 diamond tools to grind it smooth. The ultra-hard car brake disk is ready. The wear layer is approximately ten times harder than standard cast disks, and lasts significantly longer.

On the left, a disk laser feeds two high-speed coating machines. On the right, finishing touches are added to the disks.

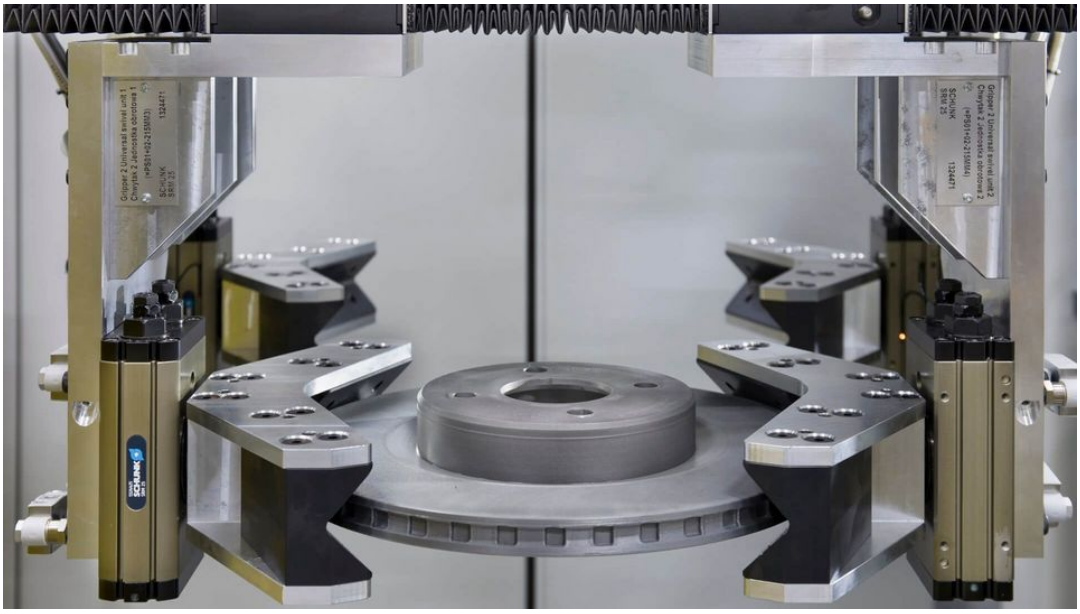
It's all in the beam

Lott: "The idea of hard-coating brake disks is an obvious one. But how?" Three processes were quickly ruled out: electrochemical coating - too dirty. Thermal coating – too slow. Cold gas spraying - too expensive and not suitable for all disks. Lott opted for the high-speed laser metal deposition (HS-LMD) variant because of its clean procedure and short processing time.

"However, the real challenge begins when it's time to put a good idea into practice," laughs Lott, "Cast iron, for example, is a tricky surface for coatings." They adhere very strongly, requiring a lot of powder. "Ultimately, the powder accounts for 60 to 70% of the manufacturing costs in the brake disk production process. So our machine has to achieve a high level of powder utilisation, in other words, use as much of the powder supplied as possible." How can Nagel reduce powder consumption now?

"We joined forces with TRUMPF during the development phase. And they use a two-pronged approach to beam shaping." The BrightLine Weld beam-shaping technology divides the laser power into a core zone and a ring zone that can be controlled independently of each other, much like a shower head with a core and ring jet. This design allows for optimal adjustment of energy and heat input. On one hand, this means the brake disk hardly warps at all. On the other hand, the coating is much thinner, requiring less powder. The second game changer in reducing powder consumption is TRUMPF's bifocal technology – part of the laser beam gently preheats the casting just before the powder spray is applied. This means that the powder adheres immediately without any problems, instead of bouncing off and ending up as expensive waste. The machine utilises up to 94% of the powder during the coating process. Nagel now has an economical production method for

abrasion-resistant brake disks compliant with Euro 7.



Thanks to TRUMPF's BrightLine Weld solution, up to 94% of the powder adheres to the brake disk during the coating process.

Electric vehicle rust resolved as a byproduct

There's a special perk for e-vehicle drivers – they can look forward to gliding through the city on extra-hard brake disks that are virtually dust-free. The corrosion-resistant coating on the disk prevents rust, making the electric car even safer. And that is particularly good news for electric car drivers. In everyday use, electric cars almost always brake using regeneration, i.e. energy recovery. This creates resistance in the powertrain, which slows the vehicle down. The mechanical brake disk is rarely used and so can start to rust.

"In the event of an emergency stop on the motorway at high speed, a corroded brake disk poses a serious safety risk as rust particles that detach can significantly increase braking distance," explains Lott. However, with hard-coated brake disks, this is no longer a concern.

Rich and healthy

Lott took over as CEO of Nagel two and a half years ago, and has fully committed to transform the company and focus on brake disks. "Our previous business was heavily dependent on the combustion engine, which is noticeably declining. With our solution for Euro 7-compliant brake disks, we aim to deliver a product that is independent of the drive system, while staying within the industry we know best." The order book confirms his approach – in the first six months, Nagel has delivered a double-digit number of brake disk systems for series production.

The automotive sector, including manufacturers and suppliers, is preparing for the major Euro 7 regulatory change. Extensive testing is already in progress, and the first car with hard-coated brake disks is anticipated to be available by late 2025. Lott is proud of the company's success, but he quickly turns serious: "There's another crucial aspect, which is that our systems will help reduce people's exposure to particulate matter, keeping them healthier. For me, it's a truly rewarding feeling."

Three steps to a Euro 7 brake disk

 The grippers securely hold the brake disk by its raw, untreated cast iron surface and transfer it into the coating chamber.
  The high-speed laser metal deposition machine applies an ultra-hard carbide layer. Laser heating and beam shaping make maximum use of the powder.
  Cross grinding: The brake disk receives its final surface finish and geometry in the grinding machine. All done! Find out more about laser deposition welding of brake disks in accordance with the Euro 7 standard here.

GABRIEL PANKOW
SPOKESPERSON FOR LASER TECHNOLOGY