Microscopic structures for vibration-resistant plugs

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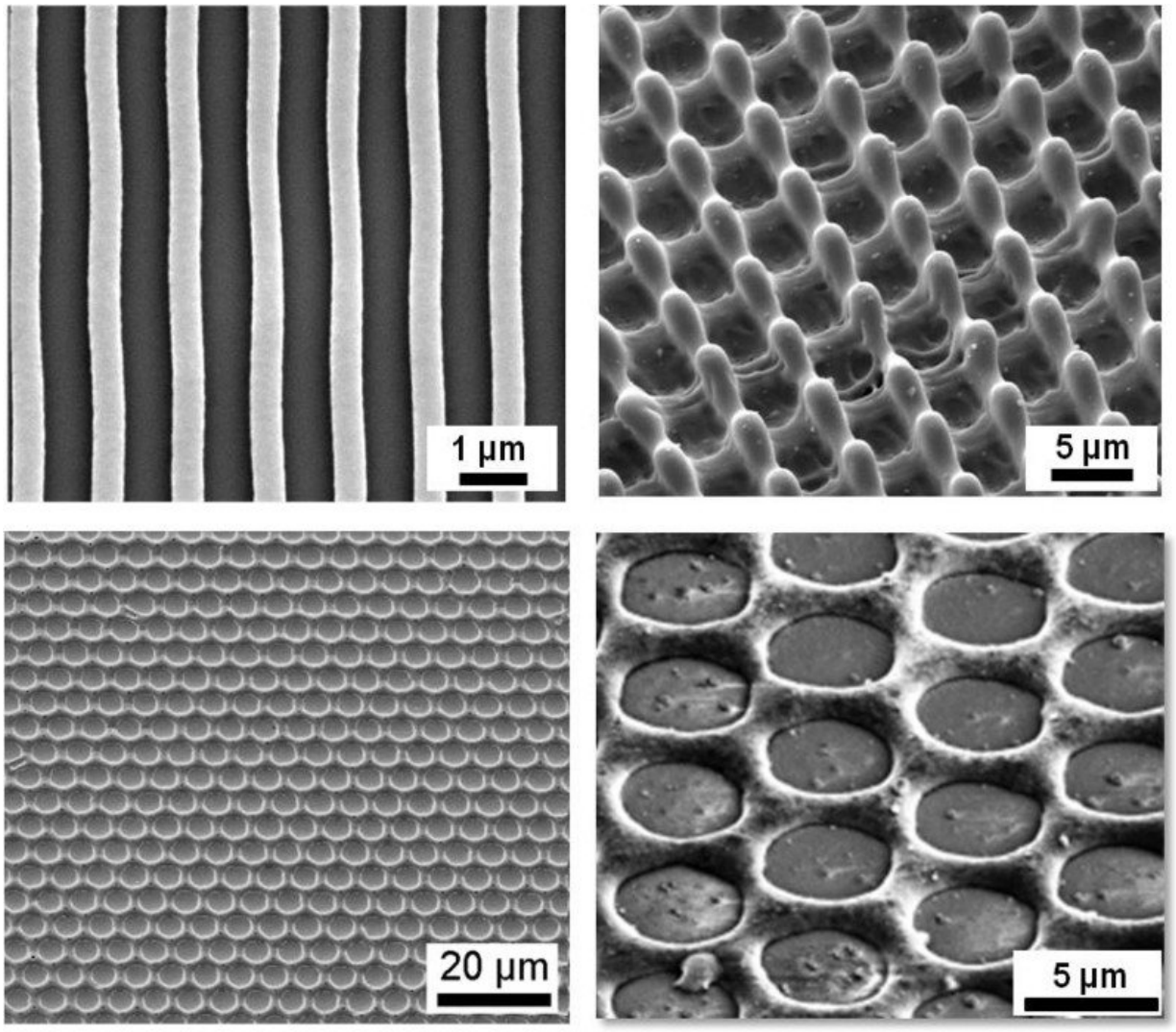

Various surface structures can be created with laser beams. Credit: Vienna University of Technology

Everyone has probably had a problem with loose contacts at some point. Electronic equipment malfunctioning is often caused by poor plug connections. In particular in the automotive industry, where electronics are increasingly being used, the quality of plug contacts plays a pivotal role – and this where materials science can come in. Special microscale and nanoscale structures, which can be rapidly and cost-effectively produced using new laser technologies, are now set to ensure increased fail safety.

Bumpy surfaces destroy the plug contact

For many years, the number of sensors and processors installed in cars has been growing, and this trend is very likely to continue thanks to the success of the electric car. "When you drive a car over a bumpy, uneven surface, making the whole vehicle vibrate, it's really the worst thing for the plug contacts", Prof. Carsten Gachot from the Institute for Engineering Design and Logistics Engineering at TU Wien explains. The plugs begin to wiggle back and forth a little bit on a tiny scale, which is known as "fretting". These minimal movements are enough to cause wear, which can ultimately cause the contact to malfunction.

Even if the probability of destroying one single plug contact is quite low, there is a high probability of malfunction because there are so many of these contacts. "Several kilometres of cables with thousands of plug contacts are installed in an upmarket, modern car", says Carsten Gachot. So it is not surprising that, according to ADAC, the German Automobile Association, electronic malfunctions are the number one cause of breakdowns.

Microstructures and nanostructures for a better hold

The problem can be combated with new discoveries in tribology – the

scientific discipline dealing with friction and wear. "The problem is that we have to simultaneously meet two requirements that are difficult to reconcile with one another", says Gachot. "On one hand, the contacts need to hold and not be loosened by vibrations either, but on the other hand it needs to be possible to connect and disconnect the plug using relatively little force."

The solution is to provide the plugs with a delicate structure. "Different patterns on a microscopic scale that are embossed into the material can drastically affect the friction and wear behaviour", says Gachot. "In simulations and experiments, we at TU Wien examined which structures gave the best results."

Burned in with laser light

So that these structures can be produced rapidly and cost-effectively, Carsten Gachot is collaborating with research groups from the University of Saarland in Saarbrücken and TU Dresden. "The crucial new concept is using laser light to produce the delicate structures", says Gachot. The wave properties of the light are used in this concept; just like complex wave patterns are made in a pond when you throw in two stones, the material surface can be illuminated with a complex wave pattern when a laser beam is split into two parts and these two parts then overlap on the surface. The resulting light pattern vaporises the material at certain points, while at other points the surface remains intact. Therefore, depending on how the beams overlap with one another, different microstructures and nanostructures can be produced in a short space of time.

"In previous methods, it would not have made economical sense to provide plug contacts with such structures", says Gachot. "But with this laser method, the structuring for all the plug contacts in an entire car can be carried out within 40 seconds, for an additional cost of 21 Euro cents

per car."

Of course, the development of microstructures and nanostructures for plug connections is not only beneficial to the automotive industry; these new discoveries can be applied to many technical sectors, from everyday gadgets to aircraft turbines.

Provided by Vienna University of Technology