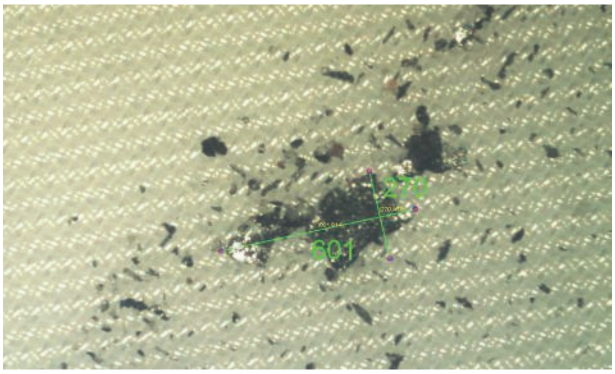
Spotless not clueless

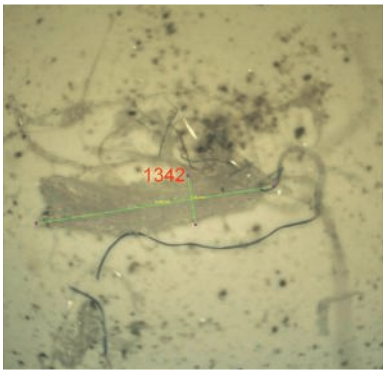
Technical cleanliness isn't new, but as vehicle autonomy becomes a reality, the necessity for clean components becomes a crucial practise for the automotive sector. By Bethan Grylls

Once regarded as a purely mechanical industry, the automotive sector has entered an electronic era as a result of increasing demand for electric vehicles, infotainment systems and driver assistance features. But, it's the rise of autonomy that has presented the most interesting challenge, according to Mark Chadwick, Global Market Manager Automotive Electronics at PennEngineering, which specialises in thin sheet fastening. As a result, a previously overlooked part of the manufacturing process has pushed into the limelight.

"Today, around 30% of the cost of a new vehicle is electronics based," says Chadwick. "That's anticipated to rise to 50% by 2030. Consequently, the demand for quality control of these components and technical cleanliness testing has risen steadily, so much so that clean manufacturing is now one of the main issues in the automotive industry."

But cleanliness is not a "new" manufacturing concept, Chadwick admits, but rather a new(ish) consideration for the automotive industry. Electricity is being moved around the vehicle from multiple power sources, mostly transmitted through copper. The copper wires and busbars are attached and connected, typically by some form of fastener. However, these fasteners can contain small shreds of metal and particulates that can break off and dislodge causing major problems, such as electrical short circuits. Both functionality and the lifetime of products are linked directly to the extent of particulate contamination.





Above: Metal swarf/dirt under microscopic analysis

"It's no longer a case of if the electrics fails your radio stops working. Now, if it fails there are lives at risk," Chadwick says.

Standards

To address these problems, there are two standards to which automotive companies are striving to adhere – ISO16232 and in Europe VDA 19 parts one and two.

VDA 19 part one states the requirements for determining particulate contamination on components. The inspection is based on a particle extraction method where the maximum amount of particulate is removed from the components, typically using a liquid to extract the particles for inspection. The standard also lays out the rules for documenting cleanliness specifications for components. The goal is for there to be no particles greater than 400μm in size after additional cleaning operations.

"This is about half the thickness of a credit or identification card," Chadwick explains.

The second part of VDA 19 focuses on fixed particles, which can be small bits of metal/swarf that are still attached to the fasteners but can become loose when the fastener is being attached or during operation.

"For example, when the assembly is screwed into place in the vehicle, the particles can be dislodged, fall out and cause problems," according to Chadwick. He continues, "This means care must be taken in the assembly areas. Part two also assumes that the components used already meet part one of the standard."

VDA 19 part two provides a guide to help eliminate particle sources in assembly processes where the required degree of cleanliness cannot be met purely by implementing part one. It guides assembly manufacturers on principles to prevent or remove particles at the point of generation.

"Until recently," Chadwick says, "the automotive manufacturing process had remained unchanged for decades. Many car makers and their tier-one suppliers have struggled to meet these requirements for cleanliness and are now having to design new ways to assemble and manufacture products, alongside hiring the expertise they need to achieve compliance."

Costs of compliance

The main challenge for the automotive industry is the cost of the process. "It's known for trying to reduce costs," Chadwick says. "So, cleaning is a balance between necessity and requirement.

"When you're manufacturing millions of components, it's impossible to economically visually inspect everything, especially when the parts and particles are so small," he contends. "You can clean them and inspect them again and again, but it's gets to the stage where the cleaning process becomes as expensive as the components themselves."

When it comes to VDA 19 part one, Chadwick says PennEngineering already meets the standards (when specified). To identify a risk, the company uses failure modes and effects analysis.

"We look at the manufacturing process and determine whether there are any opportunities for dirt to sneak in. This allows us to find ways to either reduce introducing the risk in the first place, or to devise an alternative method for cleaning."

PennEngineering also cleans and examines products to ensure that loose particles greater than 400μm are not present when the products are packaged.

"To accommodate to VDA 19 part two", Chadwick adds, "PennEngineering has designed a range of products in such a way that it reduces the risk of fixed particles becoming detached during the assembly process.

"Swarf particles and debris from the traditional cutting process can remain attached even after washing and tumbling the fasteners," he explains. "These fixed particles may break loose when a nut and bolt are screwed together, so PennEngineering offers the alternative of the blind nut and standoff range. These fasteners are sealed at one end so that any particles that do become loose will remain trapped within in the assembly as long as the mating screw is not removed."

But, this option is not always possible. As a result, the company has its stud range for use usually in busbar assemblies. The normal method of producing such stud fasteners is to cut the thread, Chadwick says. He describes this as an "aggressive approach" because it produces a lot of shavings and torn surface is noted for creating high numbers of fixed particles. "Traditional cutting processes for threads tear the base metal and will always have a risk of particle contamination," he explains.

"PennEngineering's cold forming process creates a thread using high pressure and specialised tooling to mould the thread on to the stud fastener. This leads to cleaner parts without the problem of swarf contamination.

"Due to the cold forming process deforming and squeezing the metal into the new shape, it preserves the internal structure of the metal and its properties such as strength, unlike machine cutting which can create weakness at the root of the thread."

"Many car makers have struggled to meet the level of cleanliness that electronic components demand and are now having to design new ways to assemble and manufacture products"
Mark Chadwick

Blind nut and standoff connectors contain many particles that can break off

The cleaning process takes place in a 'clean room' to prevent containments from entering the environment in the first place, Chadwick explains. These rooms will usually have sealed doors and ventilation systems, and a cleaning process for the equipment, with a "clean down" every few hours. Employees will also be required to wear protective gear that will be stored in a clean area and washed on a frequent basis.

Cleaning before installation can sometimes present issues however, Chadwick continues. "Someone can pay for a cleaning service, but by the end of the assembly process the part is dirty again." To overcome this dilemma, PennEngineering assesses where in the process is best to clean the part. "If cleaning earlier on will have no impact on the final product, we recommend customers install it and then have it cleaned after the assembly."

Chadwick says it's a continuous work in progress, with the company constantly looking to improve the cleaning process. He notes that innovation in cleaning is of particular importance as autonomous vehicles become more of reality.

Vision systems for example, will be relied on to assess hazardous situations – one only has to consider the autonomous Uber that knocked down and killed a woman in Arizona to understand why faults aren't an option.

And with such high stakes, Chadwick says discussions to tighten the existing standards are suggesting 400μm may not be good enough. "We're probably going to start looking at 200μm or maybe even 100μm.

"As vehicles are manufactured in much higher volumes and are more cost impacted," he says. "the challenge is going to be not just keeping up to pace with this advancing technology, but also finding an affordable and efficient solution."