



The evaluation of texture geometries of automotive engine cylinder liners produced by femtosecond pulsed laser processing

Laser processing enables the development of engineered surfaces by applying textures, producing enhanced functional performance such as surface friction, tactile behavior, wetting properties, and many more. Laser processing using ultra-short pulses durations in the picosecond and femtosecond region allows surface texturing with highly defined micro geometries, edges, and finishes. 5-axis laser processing enables the seamless texturing of three-dimensional components to be carried out having complex profiles.



The Manufacturing Technology Centre, located in Coventry, United Kingdom, is an independent RTO founded in 2011. As one of the UK's High Value Manufacturing Catapults (HVMC), the MTC facilitates the industrialization of innovative manufacturing ideas and manufacturing system solutions. Under the MTC's Component Manufacturing Technology group, Laser Processing forms a significant part of MTC's capabilities, covering advanced machining, surface engineering, and material joining.

The study was carried out by Niall Burt, Paul Butler-Smith, Tian Long See.

■ Measurements

The Sensofar S neo3 3D optical profilometer has become an integral part of the development of surface textures at the MTC. In a collaborative experimental study with an automotive company, as part of the European funded Prometheus project, surface textures were developed at the MTC and applied to the curved surfaces of automotive combustion engine cylinder liner segments using a femtosecond laser system. Figure 1 provides an example of a laser textured cylinder liner segment and the texture features using 3D profilometry.

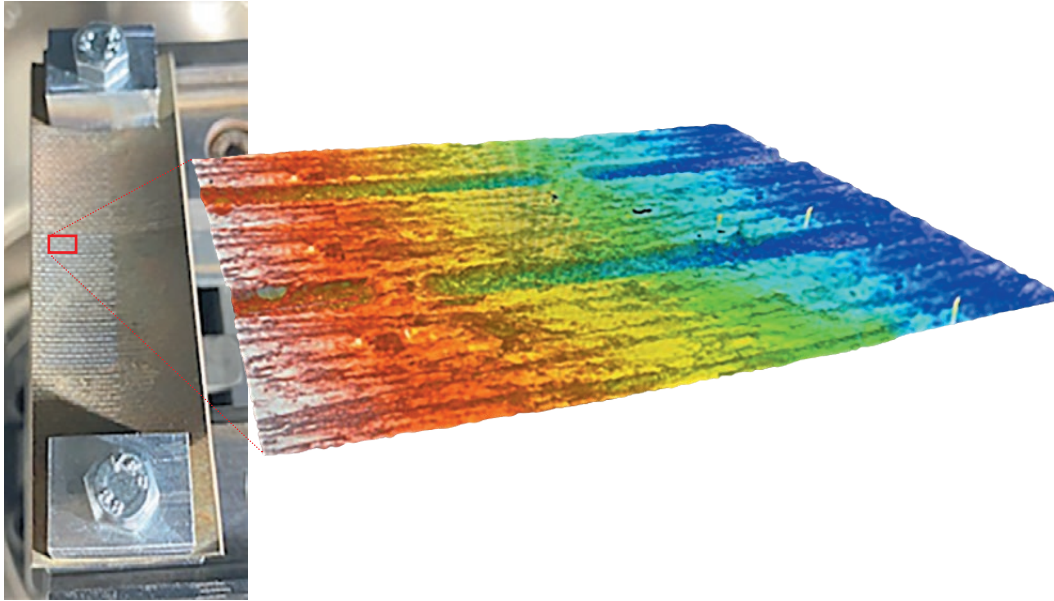


Figure 1. A automotive cylinder liner segment showing the laser produced texture and a 3-D profile capture of the textured surface

The Sensofar's integrated confocal microscope and Z axes adjustment enables the complete 2D topography layer to be captured (Figure 2).

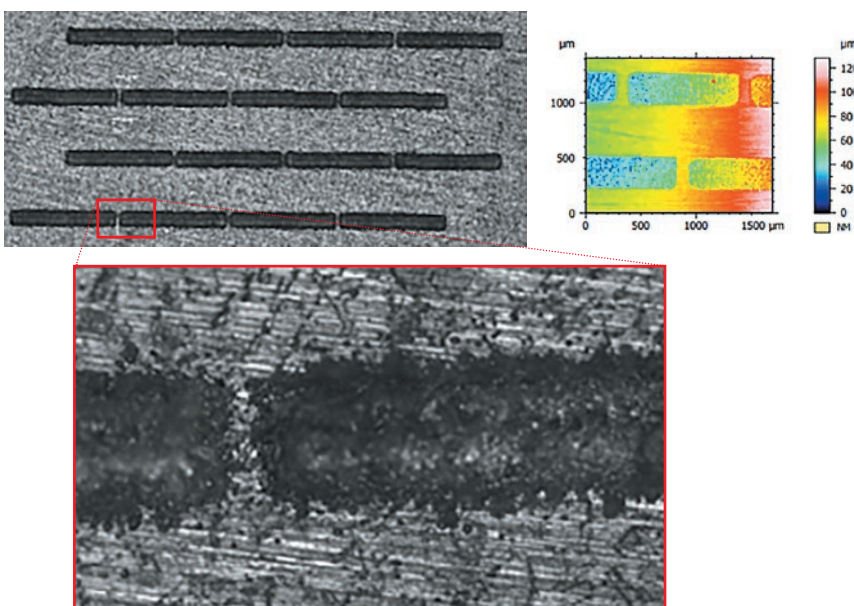


Figure 2. Topography capture and micrograph of a laser produced texture in an automotive cylinder liner segment.

Then using the SensoMAP software, the texture can be analyzed using the capture sequence shown in Figure 3. Firstly, a profile curve of the texture features is extracted from the topography layer (Figure 3a); this allows the critical dimensions of the texture geometry, such as groove width and depth, to be determined. Both the step height analysis tool (Figure 3b) and distance measurement function (Figure 3c) can be used to identify this key data, which enables the analysis of the transition between untextured surface and texture geometry, critical to the indicative frictional performance of the laser textured surface. While distance measurements give the dimension of 2 points on the curve, as manually set by the user, the step height provides the mean height difference giving a more accurate assessment of the change in depth from the laser texturing process.

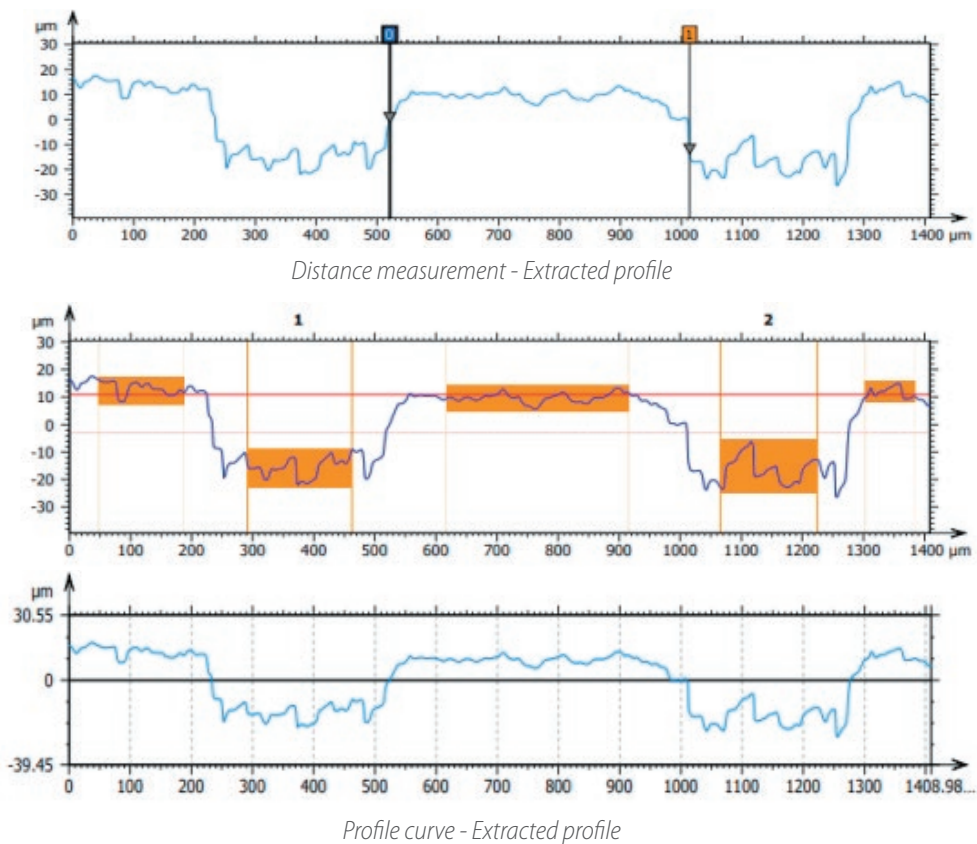


Figure 3. SensoMAP process steps for laser surface texturing profiling and analysis (a) extracted profile curve, (b) step height analysis, and (c) distance measurement.

■ Conclusions

In this study with an automotive company, the S neox optical profiler has been essential to understanding how laser texturing enhances the functional performance of cylinder liner segments. Specifically, Confocal has proven to be the top performer technology within the three of the S neox. Adding up the analysis software capabilities, we have assessed the frictional performance of the laser-textured surface.

Using the Sensofar and supporting software, we can rapidly evaluate texture designs and develop our laser texturing process to deliver results for our customers.



SENSOFAR is a leading-edge technology company that has the highest quality standards within the field of surface metrology

Sensofar Metrology provides high-accuracy optical profilers based on confocal, interferometry, focus variation and fringe projection techniques, from standard setups for R&D and quality inspection laboratories to complete non-contact metrology solutions for in-line production processes. The Sensofar Group has its headquarters in Barcelona, also known as a technology and innovation hub in Europe. The Group is represented in over 30 countries through a global network of partners and has its own offices in Asia, Germany and the United States.

HEADQUARTERS

SENSOFAR METROLOGY | BARCELONA - Spain | T. +34 93 700 14 92 | info@sensofar.com

SALES OFFICES

SENSOFAR ASIA | SHANGHAI - China | T. +86 21 61400058 | info.asia@sensofar.com

| TAIPEI - Taiwan | T. +886 988106002 | info.asia@sensofar.com

SENSOFAR DACH | LANGEN - Germany | T. +49 151 14304168 | info.germany@sensofar.com

SENSOFAR USA | CONNECTICUT - United States | T. +1 617 678 4185 | info.usa@sensofar.com

sensofar.com