Tribological Enhancement of TWAS Cylinder Bore Coatings by Mechanochemical Surface Finishing

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Mechanochemical surface finishing combines elements of mechanical burnishing with a tribochemical deposition of a solid lubricant tribofim. The treatment results in the development of a progressively plateaued roughness profile with reduced gradient roughness and increasingly negative skewness. Mechanochemically finished TWAS coated cylinder bores are found to reveal improved scuffing resistance as well as reduced friction and wear. Experimental data are supported by computer simulations.

Keywords: *mechanochemical surface finishing, twin wire arc spray, mirror-like bores*

TWAS (twin wire arc spraying), also known as LDS (German LichtbogenDrahtSpritzen), thermal spray coating technology is currently used by a number of manufacturers – including Mercedes Benz, BMW, Renault-Nissan – for aluminum engine blocks. Known advantages of LDS coated bores include a higher heat conductivity compared to GCI-liners, a possibility for additional cooling in the interbore bridge, and improved tribological properties. Unlike conventional honed GCI liners that rely on the honing grooves for oil retention, LDS coatings have surface pores that provide sufficient oil retention capacity even for mirror-like finishes.

Different TWAS wire alloys can be used to meet specific performance requirements, such as improved corrosion resistance offered by stainless steel coatings.

The corrosion resistance of the low-alloyed steel 13Mn6 commonly used for engine cylinder-bore coatings is insufficient in certain demanding applications. Chromium-containing alloys such as X20Cr13 have better corrosion resistance but are more prone to scuffing. Honing of stainless steel coated bores is also more challenging.

In this study, mechanochemical surface finishing of LDS coated cylinder bores was tested as an alternative to mirror-like finishes produced by a honing process with a diamond-tipped finish cutter. While both techniques can deliver "mirror-like" finishes, there are major differences the material compression state and tribofilm composition. The honing process is used to remove compressive stresses while the mechanochemical burnishing builds up compressive stresses in the coating layer simulating the run-in effect. However, excessive compressive stresses may cause the appearance of ridges on the bore surface due to stress relaxation. Such ridges have a negative impact on the piston bore tribology and may trigger scuffing. Therefore, a special emphasis should be placed on the process optimization and GD&T controls.

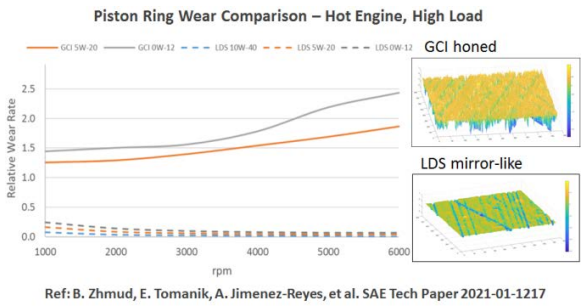

Figure 1 Piston ring wear reduction for mirror-like bore finishes. An even bigger effect is expected for mechanochemically finished LDS bores due to the presence of solid lubricant.

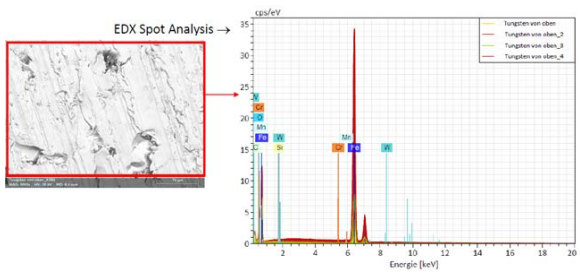

Figure 2 The presence of solid lubricant has been detected in the topmost surface layer of LDS bores after mechanochemical surface finishing.