# Applied Nano Surfaces

## It's all about friction.

BY **DAVID CHOBANY**

Sunnen Products recently announced a partnership with Applied Nano Surfaces (ANS) to advance friction and wear reduction technology. Sunnen and Sweden's Applied Nano Surfaces (ANS) have entered into a joint market development agreement to advance technology and applications based on the Triboconditioning process recently patented by ANS. The process reduces friction and wear on various steel and cast iron surfaces while improving surface finish, preventing seizures, and enhancing product life.

Key applications include automotive engine components such as valve train parts, cylinder liners, crankshafts and connecting rods, as well as industrial applications such as hydraulic motors, rock drills, pumps, chains, gears and compressors.

"ANS is on the leading edge of friction reduction technology," said Chris Miltenberger, President and CEO of Sunnen Products Company. "We are excited about working with ANS on the development of new products and surface finishing methods which will bring unique solutions to all segments of the manufacturing industry.

Headquartered in Uppsala, Sweden, ANS offers surface treatment technologies on a range of industrial and automotive applications.

Triboconditioning is a combined mechano-chemical surface treatment method patented by ANS. The treatment can be implemented as a superfinishing operation and carried out using standard machines, e.g. for honing, turning, or milling. The result is a smoother surface covered with a low friction tribofilm that reduces friction and the wear of the component.

ANS offers the Triboconditioning® technology on a license basis to component manufacturers and system builders.

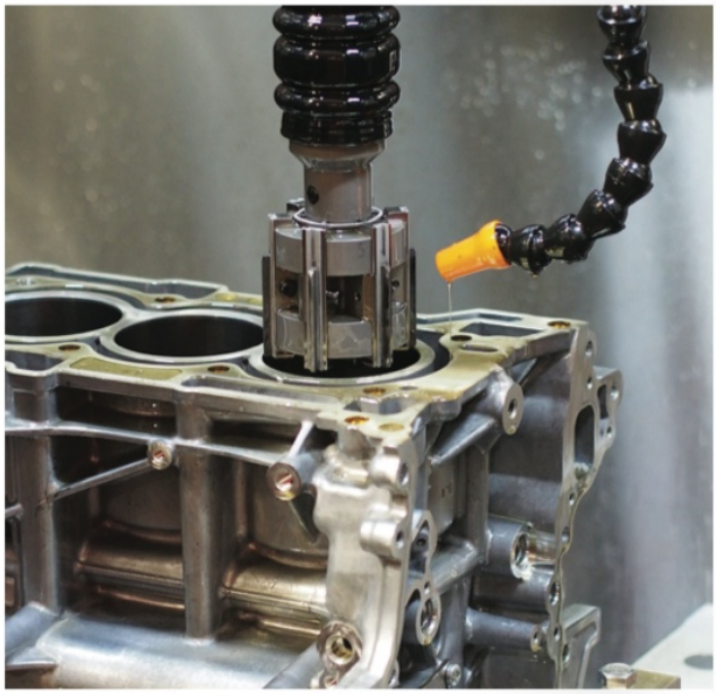
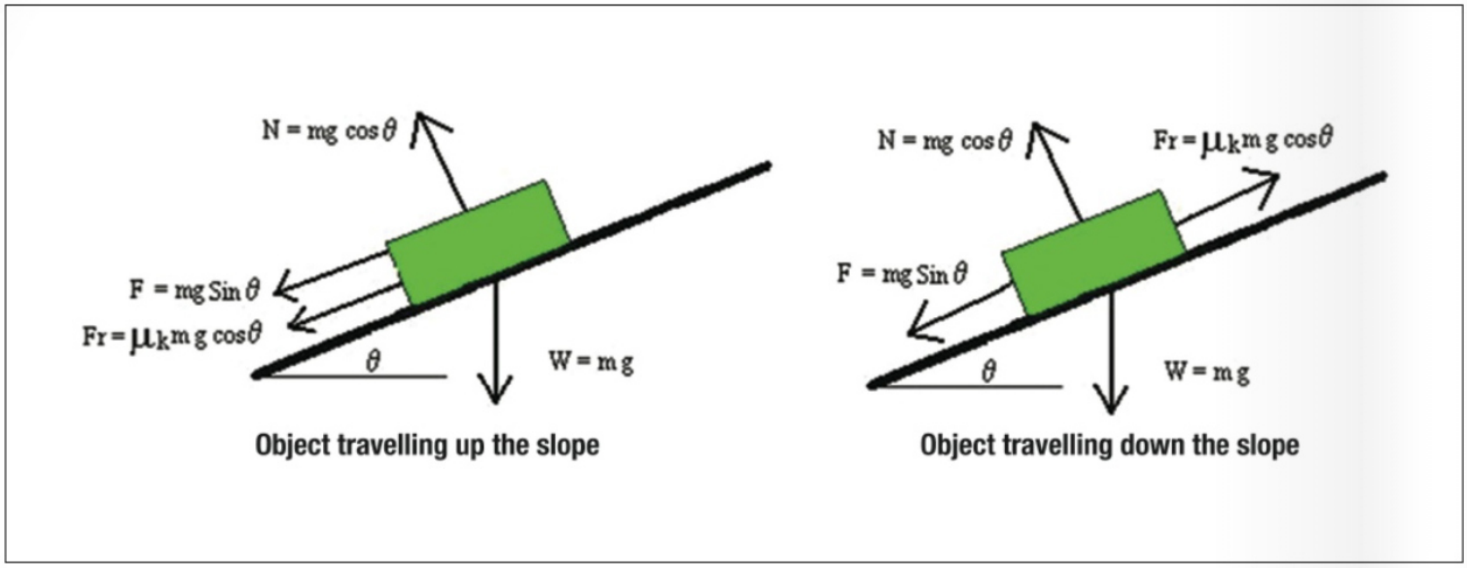


**Figure 1. The Triboconditioning® treatment of an engine block.**

### How it is done

The ANS Triboconditioning® process combines mechanical burnishing with tribochemical deposition of a friction- and wear-reducing compound onto the component surface. A tool is pressed and slid against the component in the presence of a special reactive process fluid. As the tool passes over the surface it triggers a tribochemical reaction within the process fluid which gradually deposits a low friction tribofilm on to the surface of the component.

The pressure applied on the tool also leads to a burnishing effect as some of the asperities on the surface will be leveled off and the valleys be gradually filled with the friction-reducing compound. As the process is technologically simple and, in most cases, can be



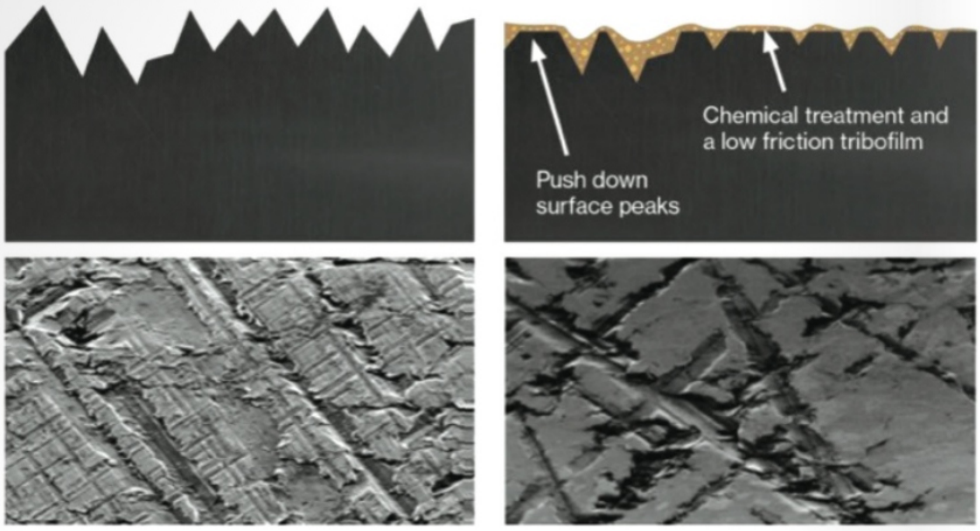
done with regular surface finishing equipment, it is very cost efficient in mass production environment. The ANS Triboconditioning® process is therefore perfect for in-house manufacturing as a part of the component manufacturer's production line.

### Effect

The ANS Triboconditioning® technology greatly improves the tribological performance of the component in terms of wear-resistance and lowered boundary friction. The surface properties also increase the lubricant film strength which makes it ideal for deployment in combination with modern energy-saving low viscosity lubricants.

### Driving Force – Why

The continued pursuit for better fuel economy by reducing engine friction helps maximizing out the miles per gallon. The pursuit for better fuel efficiency stands behind




**Surface before**

Typical surface before Triboconditioning® treatment. Surface peaks will increase friction and wear on the component and/or the countersurface.

**Surface after**

Typical surface after Triboconditioning® treatment. The surface peaks have been pushed down without removing any material, thus improving the topography while keeping the oil retention capacity intact. In addition, the tribofilm has been chemically diffused into the component surface.

many recent advancements in engine technology. The average fuel consumption, normalized to engine output, dropped from 10 L/100 km (23.5 mpg) in the 1980s to 5L/100 km (47 mpg) now-a-days. "Downsize and charge" has become the major development trend alongside broad acceptance of fuel stratified injection (FSI) direct injection technology.

Estimated energy losses within the internal combustion engine. This loss can be further subdivided, in a proportion 9:1, into a dissipative part (viscous dissipation due to lubricant flow) and a frictional part (mostly due to boundary friction in piston ring/cylinder bore, crank train and valve train systems). The dissipative losses can be reduced by using lower-viscosity oils and smaller displacement volumes. The frictional part can be reduced by using antifriction coatings on performance critical parts as well as by deploying special friction-reducing additives in engine oil. Unfortunately, use of additives in oil may cause exhaust catalyst poisoning and so must be constrained. This makes coatings an attractive alternative.

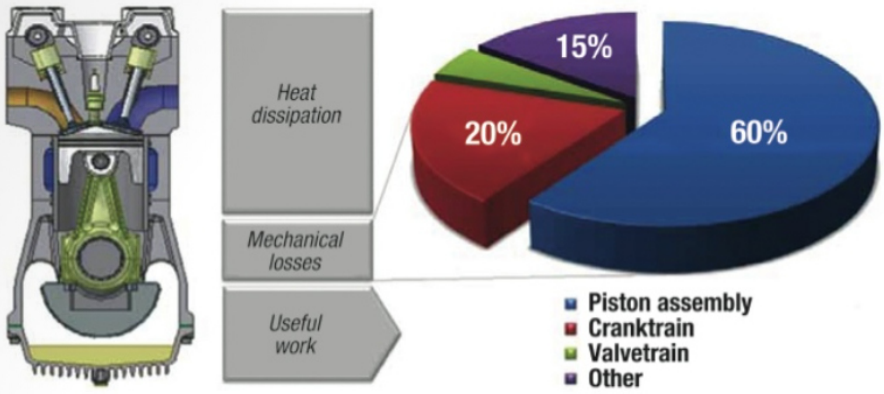



Figure 2: Energy Loss

### Anti-friction Coatings

In an internal combustion engine, estimated 10–20% energy is lost due to friction, see Figure 2. Today, various coatings are used in automotive engineering to compensate deficiencies of bulk materials. Coatings can be used to improve wear resistance, corrosion resistance, appearance, adhesive properties, etc. Well-established methods for enhancing the tribological properties of various automotive components are chrome plating, ferritic nitro-

carburation and phosphatation. Nikasil, Alusil or wire-arc sprayed iron coatings represent more recent developments which have made their way to market during the past two decades and are currently used in a number of production engines in order to improve oil film retention and to reinforce cylinder bore walls in aluminum engine blocks. Alodine EC2 electro ceramic coatings, are currently being evaluated for application in small displacement aluminum engines.

### Fundamentally Different Philosophy

From an automotive engineering perspective, whenever advancements in coatings are discussed, one often tends to focus exclusively on hard anti-wear coatings such as diamond-like carbon (DLC), silicon carbide (SiC), tungsten carbide (WC), titanium nitride (TiN), chromium nitride (CrN), etc., produced by chemical (CVD) or physical (PVD) vapor deposition. Hard anti-wear coatings are used to protect fuel injection valves, tappets, piston pins, piston rings, ball joints and other wear-critical components. Antifriction coatings serve a different purpose: to reduce friction, thereby minimizing dependence on the additive package.

In an attempt to combine the mechanical toughness of hard coatings with high lubricity, composite PVD coatings such as Balinit C (WC/C, Balzers Ltd) and MoST (MoS2/Ti, Teer Coatings Ltd) exhibiting self-lubricating properties have been developed. Soft sacrificial coatings represent a fundamentally different philosophy in the development of antifriction and anti-wear coatings: the coating can be sacrificed in action while protecting the coated parts.

### Invented a New Technology

As an example of such coatings, one can mention Molykote solid lubricant coatings developed and manufactured by Dow Corning. Molykote coatings are based on MoS2 as the main friction-reducing component, but they may contain a number of other ingredients such as graphite, resin binder, corrosion inhibitor, etc. required to control consistency, adhesion, corrosion resistance, appearance and other properties. A similar concept has been used in the development of EcoTough coatings for piston skirts by Federal-Mogul Corporation.

### Significant Reduction in Friction

The ANS process, known as Triboconditioning®, is a dedicated superfinishing process that combines elements of extreme pressure mechanical burnishing of the component surface with a tribochemical, or mechanochemical, deposition of a low-friction anti-wear film. The mechanical treatment is essential for improving the surface finish by leveling off asperities and building up compressive stresses within the underlying material, and for initiating the triboreaction that leads to the in-situ formation and interfacial nucleation of appropriate friction modifying compounds, such as transition metal dichalcogenides, amorphous carbon, borates, phosphates, etc., onto the said surface. The ANS process has been successfully applied to improve the tribological properties of cylinder bores and valve train components. Triboconditioning of cylinder bores/liners can be carried out using regular honing equipment. Triboconditioned engine blocks show a significant reduction in friction mean effective pressure (FMEP), which is expected to translate into a higher power output and better fuel economy for the engine. Not

less important is the fact that piston ring wear, blowby and oil consumption are significantly reduced as shown in Figure 3.

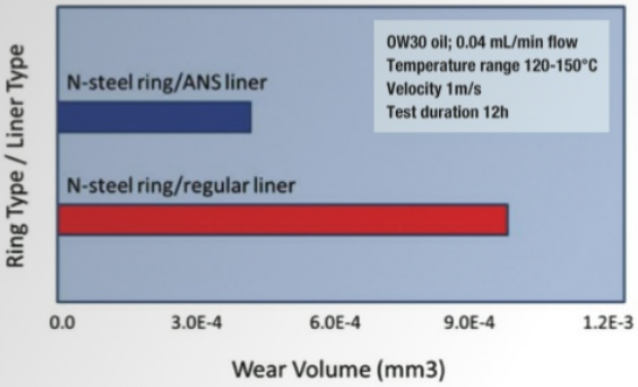
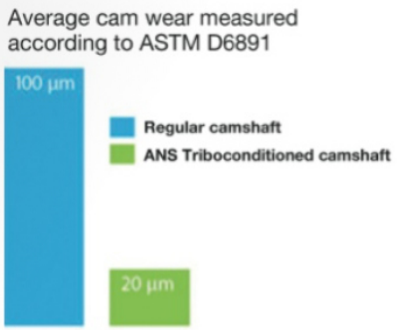



**Figure 3: Reduction in piston ring wear due to cylinder bore Triboconditioning.**

Many components have and continue to be tested using Triboconditioning and after treatment have resulted in:

- Improved oil film strength
- Improved surface finish and surface integrity
- Friction reduction
- Wear reduction
- Wide operating temperature range




Reduction in cam lobe wear for chilled iron camshafts due to ANS Triboconditioning®

The ANS Triboconditioning® treatment is suitable for any machined parts that are made of steel, cast-iron and similar ferrous alloys. The process is especially suitable for components that are manufactured in larger series amounts, which certainly pertains to engine manufacturing. These improved surface finishes are certainly going to be continued to be used and refined.■

David Chobany is the Technology and Sales Director – Americas for Applied Nano Surfaces. For more information, email david.chobany@appliednanosurfaces.com or go to appliednanosurfaces.com.