It's All About the Surface - The Role of Tribological Thin Film Coatings in Rolling Element Bearing Applications

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Over the past three decades, advancements in steel making and improvements in geometrical accuracy in manufacturing have shifted the initiation location of rolling element bearing damage from the subsurface to the near surface. In addition, modern application demands are now increasingly driving bearing operating conditions toward insufficient, or 'boundary' lubrication and hence, roller and raceway surface durability is a key life limiting factor. The ability to modify and control surface properties is playing an increasing role in the research and development of next generation bearing components. This paper presents an overview comparing traditional surface treatments with nanostructured ES® (Engineered Surface) coatings using advanced microscopy techniques and describes their behavior in high pressure tribological applications such as rolling element bearings. In particular, data from studies on a WC/a-C:H coating series developed by Timken are presented to demonstrate performance in a variety of challenging bearing damage scenarios including smearing, low λ (lambda) fatigue, debris-laden environments, and oil-off conditions. At a higher level, major global trends that impact industry today are reviewed, such as the need for increasing vehicle and machine efficiency and minimizing maintenance and operation expenses in energy applications such as wind turbines. Although bearing designers usually intend to keep components fully separated in steady operation with a lubricant film to avoid steel-on-steel contact, a common technical theme going forward is the design-stage acceptance that rolling element bearings may need to survive long periods in application with insufficient lubrication to maintain full surface separation. While technologies such as engineered thin film surface coatings have been applied in industry on bearings for more than 10 years, they are expected to be increasingly utilized to protect functional surfaces looking forward. As understanding of their process-property-performance relationships increases, alternative methods of preparing and utilizing these coatings are being explored as well.