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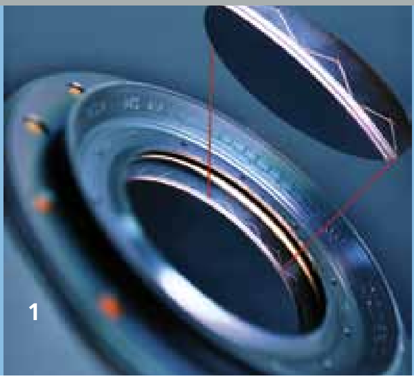

1 *Coated radial shaft sealing ring with reduced friction (Friction^PLAS).*

FRICTION AND WEAR REDUCTION USING FUNCTIONAL PLASMA COATINGS

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Status quo

For many technical applications, coatings are used on metallic materials to reduce friction and wear. This prolongs the lifetime of products and saves energy accordingly. In contrast, using such coatings on plastics, and in particular on sealing elements made of flexible elastomers ("rubber"), demands specific technical requirements on the coating.

Friction^PLAS and Friction^PLAS black coatings from Fraunhofer IFAM

Therefore the PLATO scientists at Fraunhofer IFAM has developed different plasmapolymeric and polymer-like coating systems that comply the specific requirements on flexibility with simultaneous low friction and wear for plastics and elastomers – Friction^PLAS – on the one hand as well as for plastics and metals – Friction^PLAS black – on the other hand. Furthermore, coatings have been developed which are able to change the haptic properties of elastomers significantly.

Advantages of Friction^PLAS and Friction^PLAS black coatings

The hardness and thickness of the coatings can be adapted to the substrate material and the specific application. The nanohardness can be tailored within a range from 0.04 to 20 GPa. The thickness of the coatings is usually between 0.5 and 4.0 µm. Low friction is achieved over a wide speed range – even if there is no lubrication.

Avoiding an influence on the elastomeric properties of the substrate, the coatings can be tailored in flexibility. The coatings also exhibit considerable chemical resistance to lubricants and good thermal stability up to 250 °C. Constant surface properties are achieved at both high and low temperatures.

The described coatings are thin films, meaning that production tolerances are generally fall below value. Even ultra-fine surface structures can be replicated. The coating deposition process permits a customized film adhesion depending on specific substrate materials. Furthermore the process is scalable and enables favorable coating costs accordingly.

The process is in principle suitable for small and large components – for example, radial shaft sealing rings, O-rings, plastic rails, or metallic components (made of aluminum, copper, titanium, steel, stainless steel etc.).

Applications

The range of applications of Friction^{PLAS} coatings covers one-off, short duration applications – for example, during assembly – through to continuous repetitive motion, e. g., pneumatic cylinders or radial shaft seals (Fig. 1). Due to the low adhesion forces (adhesion reduction) of the coatings surface on the component's far side, the coatings are also ideal for preventing so-called "Monday morning effects" as well as longer-term sticking together of static contacts.

In contrast, the Friction^{PLAS}black coatings are harder designed and are hence suitable for plastics and metals. They are very wear resistant and can replace, for example, anodized surfaces.

Measurement technology

A versatile tribometer is available for evaluating the frictional forces of components with and without coatings (Fig. 2+3). It allows the friction to be measured in both the dry and lubricated states at temperatures up to 150 °C.

Furthermore, the wide range of advanced analytical equipment at Fraunhofer IFAM allows the surfaces to be characterized before and after friction and wear tests.

Technical information

Friction^{PLAS} coating

- Plasmapolymer (organic to glass-like)
- Nano-hardness H = 0.04-7.00 GPa
- Coefficient of friction[1] against a dry steel ball μ_{Steel} = 0.17
- Surface energy 21.3-41.0 mN/m

Friction^{PLAS}black coating

- Polymer-like to diamond-like
- Nano-hardness H = 7-20 GPa
- Coefficient of friction[1] against a dry steel ball μ_{Steel} = 0.14
- Surface energy 32-38 mN/m
- Si:DLC (a-C:H:Si) with doping of 3 % Si

[1] The coefficient of friction is amongst others very dependent on factors such as the contact geometry, roughness, load, and deformation properties of sample and counterpart.

2 *Versatile tribometer (UMT3) with oscillating drive.*

3 *Tribological test: Ball against oscillating elastomer plate.*