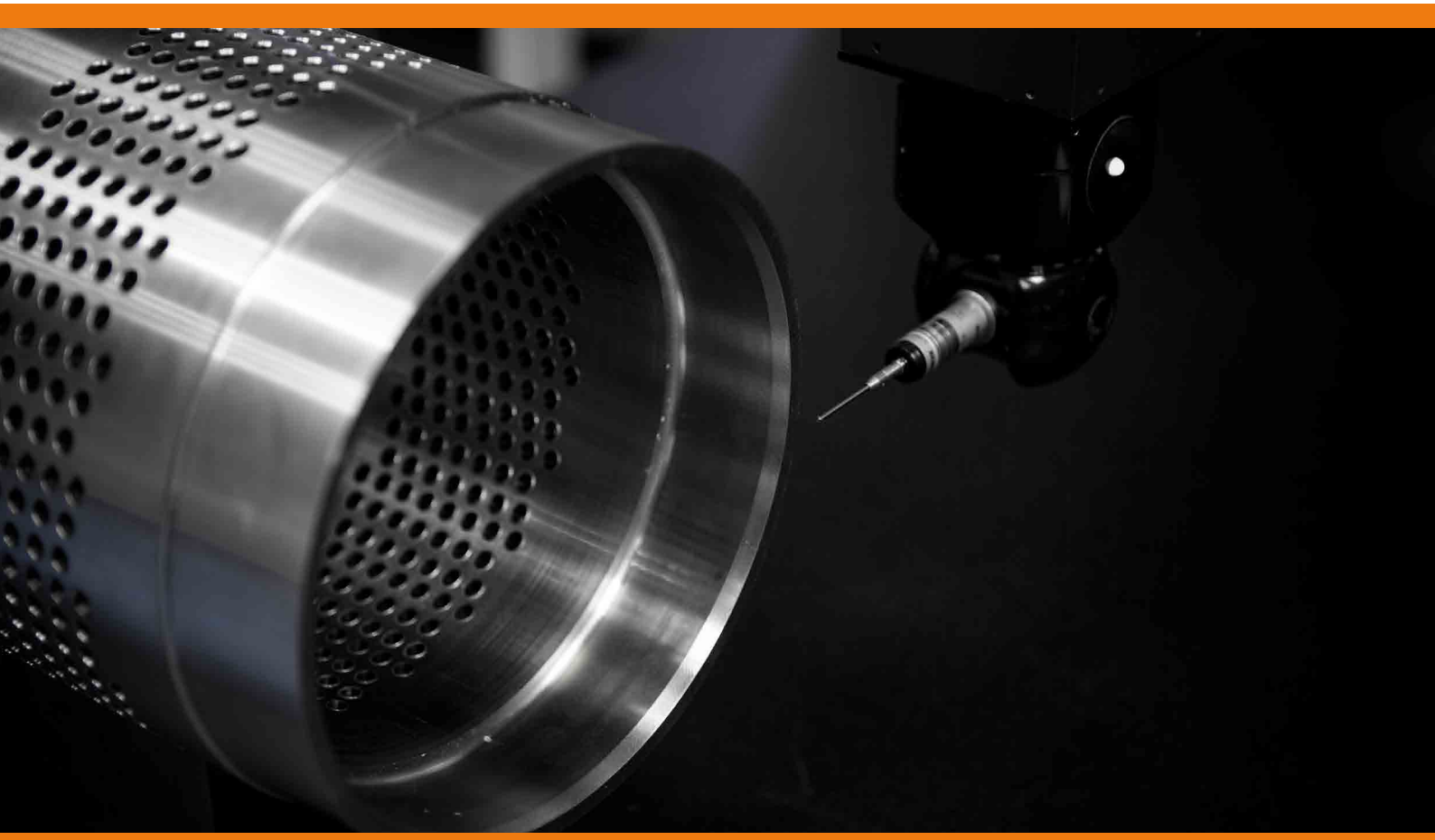
European Metrology Research Programme

Delivering Impact



New standards for nano-testing

Nanomaterials have a range of desirable properties such as increased strength, high elasticity and electrical conductivity making them desirable for use in a large range of applications. These properties are being used to develop the next generation of products in the transport, energy and manufacturing industries. However, while the properties of nanomaterials are attractive, they are not always well understood, and manufacturers need standardised methods to assess their performance.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Friction and wear in industrial processes waste energy and degrade materials. Durable engineered surfaces that reduce friction and wear, based on nanoscale surface coatings, can be used to develop high-performance products and improve process efficiency in transport, energy generation, manufacturing and mineral extraction.

Low-friction thin-film nanomaterial coatings are increasingly applied to components to protect their surfaces and extend in-service life by reducing wear due to friction - for example, thin diamond-like coatings are applied to drill bits to prevent material loss at the nanoscale.

The design and manufacture of improved components with nanomaterial coatings require a good understanding of the coatings mechanical properties and how well they adhere to the underlying bulk material. The current practice of using tests designed for performance testing of high friction materials such as those used in vehicle clutch and brake mechanisms can lead to inaccurate results for low-friction coating applications.

A number of new test methods have been developed to test the low friction properties of diamond-like coatings, for example, a ball in contact with a spinning disc can be used to assess resistance to movement by a surface. Another test method that enables durability testing of material surfaces under near in-service conditions is nano-scratch testing. This technique uses a sharp stylus to create a scratch on the material's surface. The resistance to this movement and the depth of the scratch produced indicate surface wear properties important for in-service performance. Currently there is a lack of written standards outlining how to robustly and consistently conduct these tests, placing industrial reliance on inappropriate and time consuming techniques designed for materials with vastly different friction and wear properties.

Solution

The EMRP project *Metrology to assess the durability and function of engineered surfaces* investigated methods to accurately measure the applied load during testing - a key parameter in determining a materials friction coefficient. It also investigated how these measurements experience small changes over time due to instrument drift. Extensive testing of nano-material coatings using both ball on spinning disc and nano-scratch testing has increased the understanding of these measurement methods for low-friction and wear measurements on engineered surfaces. This has enabled the project to propose good measurement practices for conducting these types of friction and wear testing which will contribute to increased industrial test accuracy.

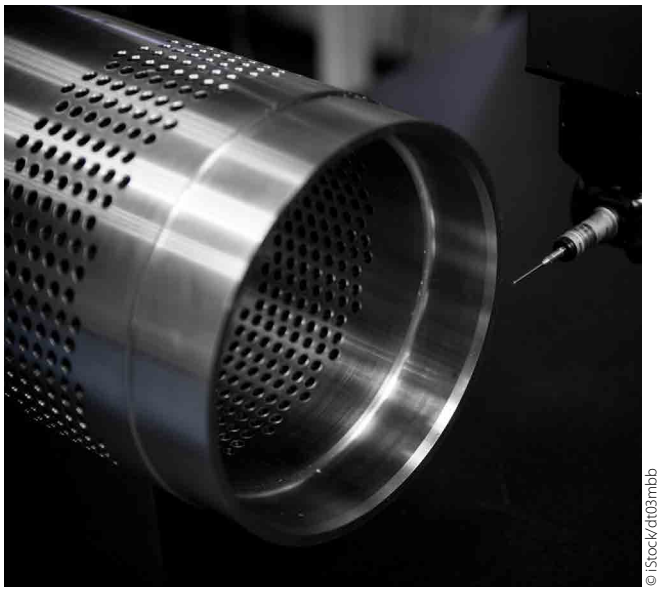
Impact

The project's good practice guidance on the ball-on-disc friction test method has contributed to a new international standard ISO 18535:2016: *Diamond-like carbon films - Determination of friction and wear characteristics of diamond-like carbon films by ball-on-disc method*. The guidance developed on nano-scratch testing will also be used in a new standard being developed by the CEN Technical Committee on Nanotechnologies.

Having these new documentary standards issued, specifically written for measurements of diamond like coatings and engineered surfaces will support European industry's wider efforts to improve the quality and harmonisation of measurements of nanomaterial properties. High-quality, comparable data will improve understanding of nanomaterial coatings and support the development of improved high-performance products, with longer lifetimes and greater efficiency. Transport, energy generation, manufacturing and mineral extraction are just some of the industrial users who will benefit from optimising the design of engineered surfaces as a result of standardised test methods.

Metrology for engineered surfaces

Companies relying on highly precise production tools and engineered surfaces need to understand how they wear. The EMRP project *Metrology to assess the durability and function of engineered surfaces* developed techniques for measuring nano-scale wear and localised heating, low-friction coating performance, and the mechanical degradation of tools. These techniques will enhance industrial competitiveness and reduce environmental impact by supporting the adoption of low-wear, low-friction surfaces in sectors including transport, energy generation, manufacturing and mineral extraction.



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