European Metrology Research Programme

Delivering Impact

Modelling material change

Manufacturers need to understand the surface properties of new materials and coatings before these can be incorporated into innovative products. However, a whole range of measurements are needed to fully characterise surfaces. This can be time consuming as often only a single parameter can be ascertained by an individual type of test. Therefore models relating different surface properties to each other are needed to deliver lifetime in-service performance predictions.

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

When manufacturers of plastic's or coatings develop new products, they need confidence in how they will perform in service when subjected to mechanical forces. For example, understanding how a material's surface performs in wear situations is important in determining a products durability. Wear is a complex process with many mechanisms involved, therefore, new products are often optimised using physical models or simulation which require data from testing.

How a material's surface responds to loads over time relies on inter-related mechanical properties and these can be measured on a micro-scale using nano-testing techniques. The interpretation of test results in order to generate mechanical property data is often difficult as you need to physically evaluate contact measurements in order to understand the mechanical properties of the surface. Many individual property tests are needed to model or simulate a surface's performance. This takes a significant length of time and slows the adoption of innovative new materials into products.

Speeding this process through accelerated testing techniques and inter-relating their results using software models would enable industrial researchers to predict how surfaces will perform under expected in-service conditions, based on measurements of just a few parameters. This could reduce the need for extensive long term materials testing, saving considerable time for companies wanting to implement innovative materials.

Solution

The EMRP Project *Dynamic mechanical properties and long term deformation behaviour of viscous materials* developed and validated models which could reduce the level of physical testing needed to establish a material surface's behaviour over its lifetime.

The deformation model developed by the project relates different material surface properties, including creep and dynamic parameters to each other. This enables surface property predictions to be made based on a smaller range of measurements. The project measured different plastic materials using a variety of trusted techniques, creating extensive, reliable data on creep and other properties, which was used to validate the model. This validation established the model as a recognised method of relating different surface mechanical properties to each other.

Impact

The Saxonian Institute, a surface mechanics consultancy, improved and validated its materials models within this project. These models have been incorporated into its commercially available software Film Doctor©, and are now helping users better understand the inter-relation of material surface mechanical properties and how these will impact new products. Saxonian Institute customers in automotive, engineering and consumer products are already benefiting from these extended models.

Anton Paar, a manufacturer of material characterisation instrumentation has incorporated the Saxonian Institute's approach into their nano-indentation instrument, improving their instrument's ability to provide detailed surface material property measurements to customers.

The model has also been licenced to the FP7 Project, iStress, which is investigating novel coatings for reducing wear in diesel engine fuel injectors. The Saxonian Institute has modified the model to enable it to be used as a design tool to predict coatings performance. The most promising coatings formulations can then be tested to confirm properties. This reduces early stage testing and quickly homes in on the most promising research areas.

These and other industrial research applications will benefit from the material property models through reduced testing time of materials and components, allowing manufacturers to bring improved products to market more quickly.

Metrology for mechanical properties and deformation rates of viscous materials

The EMRP project *Dynamic mechanical properties and long term deformation behaviour of viscous materials* provided validated indentation and contact methods to measure the shape, mechanical properties and deformation rate of viscous materials. New calibration routines and detailed analyses of measurement errors are helping instrument manufacturers to understand and improve the performance of their products, and new measurement and analysis protocols will improve the ability of the nano-indentation community to measure viscous materials.

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

www.euramet.org/project-IND05

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