European Metrology Research Programme

Delivering Impact

Validating high-performance polymers

Polymers offer advantages from reduced weight to precise shape manufacture and are widely used in many applications. However, their effective use in specialist precision products has been hampered by a lack of reliable data detailing their mechanical properties and small-scale surface features. Improvements to the profilometers used to measure polymers, and the data they provide would support their uptake in high value applications.

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

Polymers are widely used in high-performance applications such as electronic coatings and medical implants and are finding increasing use in precision instruments incorporating sophisticated plastic optics. Plastic optics readily provide more complex optical shapes than glass and need to be accurately manufactured and well characterised in shape and surface profile to ensure their performance.

Micro surface features and other small height change measurements (profilometry) are used to control manufacturing and quality assurance processes. These delicate measurements are usually made with a thin probe in contact with the surface of the material being measured. The weight of the probe requires careful control so that it doesn't damage the material or cause material build-up on the probe itself, both of which effect the measurements. This is particularly difficult to achieve for polymers that are relatively soft and can be easily distorted by the measurement process. Improvements to the profilometers used to measure polymers would support an increased understanding of their properties and allow more-effective exploitation in innovative products.

Solution

The EMRP project *Dynamic mechanical properties and long term deformation behaviour of viscous materials* developed algorithms for profilometer contact probes, which enable correction for the distortions created during surface measurements of soft materials such as polymers. The project team produced well-characterised step height change reference materials and used these to compare surface contour measurement methods. This has enabled the development of new calibration methods with well characterised uncertainties for profilometry measurements.

Impact

Mahr GmbH, a leading manufacturer of measurement equipment, used the step height reference materials to assess its profilometer's performance when measuring polymers. The knowledge gained through this assessment, along with the project's correction algorithms have helped Mahr to optimize the measuring force of its profilometers. This significantly reduces surface damage and measurement problems caused by material accumulating on the profilometer probe itself. Applications include measurements of plastic optics, as well as diamond-turned moulds for optical components.

The profilometer correction algorithms developed by the project have been incorporated in the DIN 32567 standard. This ensures wider access to these data correction techniques for instrument manufacturers and will ultimately lead to improved profilometry data for their customers.

Metrology for 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 for the instruments used in the project will help 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.

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Xiaodong Hou

NPL, UK
+44 20 8943 6637 | Xiaodong.hou@npl.co.uk

11326/0916 - IND05 14069