



## Precise measurements for microparts

The Swiss watch industry, worth 16 billion euro per year, is centred on the quality of precision micro-mechanisms, similar manufacturing techniques are also essential in the automotive and medical device industries. Product innovation to improve performance often involves new designs for ever smaller components. As parts shrink, confirming that nanoscale dimensions meet specifications requires improvements to measurement methods used for quality assurance.

### **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

Car fuel injection systems, medical pumps and high-end watches are all examples of applications where smaller mechanisms have supplied improved performance and enhanced customer satisfaction. In advanced products, reducing the size of mechanical parts and introducing greater manufacturing precision improves reliability, durability and increases efficiency, whilst minimising size and weight.

Ultra-precise machining is used to create parts with miniscule holes, recesses and complex curves that must conform to tight tolerances to ensure that the final mechanism runs smoothly. The advent of new materials and the introduction of processes from the semiconductor industry is revolutionising micropart production. These techniques provide increased manufacturing accuracy, greater design freedom and enable higher manufacturing volumes to be achieved. However, measurement methods for verifying that microparts meet specifications need to be upgraded to keep up with manufacturing developments.

One approach for examining these small components uses tactile probes integrated into high-precision Micro-CMM machines for traceable and precise measurement of small dimensions. However very small parts can have features that are inaccessible to existing probes, so optical and X-ray computed tomography (CT) measurement methods are used in production quality assurance. Improved links between the tactile, optical and CT measurement methods are needed to improve quality control for micropart mechanisms.

# Solution

The EMRP project, *Multi-sensor metrology for microparts in innovative industrial products*, developed new smaller tactile probes and improved links between different measurement techniques to reduce discrepancies. The project developed a new tactile probe manufacturing method, based on electro-eroding tungsten carbide rods to produce shafts with tips half the size of current probes. These enable smaller features to be accurately measured as well as strengthening the probe-tip joints. Project researchers also used software to simulate the response of a micro-CMM when using the new probes to separate different sources of measurement error and therefore improve accuracy.

With smaller probes and greater measurement accuracy, project partner METAS, the Swiss Federal Institute of Metrology, now offers an improved precision measurement service for calibrating small and complex shapes used to transfer measurement accuracy to industrial micro-CMM used for production quality assurance.

# Impact

Nivarox, a member of the Swatch Group makes many of the parts used in their watch mechanisms. It needs to be confident that these complex microparts meet specifications to maintain the Swiss watchmaker's reputation for quality.

Nivarox was one of the first to have the dimensions of complex microparts precisely determined using a new measurement facility, developed in the project. These artefacts are now used for quality assurance, to provide robust confirmation that Nivarox's tactile and optical measurement systems are operating correctly. This gives Nivarox greater confidence in their ability to identify

machine drift's that edge manufactured components nearer to product specification limits. By spotting this early, corrections can quickly be made before parts fail tolerances, so reducing waste and improving production efficiency.

European precision engineering companies, such as Swatch, rely on accurately measuring complex microparts to ensure product quality. Reliable dimension measurements underpin mechanism innovations, helping them remain world leaders in very competitive industries. As a result of this project, companies can have improved confidence in the quality of microparts and the smooth operation of complex mechanisms. This has the potential to increase innovation and help European industries remain cost-effective and competitive on a global stage.

## Multi-sensor collaboration

The EMRP project *Multi-sensor metrology for microparts in innovative industrial products* developed a reliable framework by linking data from tactile probes and optical sensors using reference artefacts with complex shapes to increase 3D measurement accuracy. To support the greater use of X-ray computed tomography (CT) for determining inaccessible dimensions the project developed a simulation to identify systematic measurement errors. This has resulted in a 50% increase in the accuracy of determining dimensions using CT.

The precise manufacture of miniscule parts is essential for the smooth operation of a wide range of small mechanisms in the automotive, medical and telecommunications industries. Products, such as micro gears, fuel injection and drug delivery systems, all rely on accurate and reliable measurements in 3D.



## EMRP

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