Poster

EMRP RESEARCH PROJECT: NEW TRACEABILITY ROUTES FOR NANOMETROLOGY

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Through the iMERA European project the metrology community and its stakeholders identified the major challenges for European metrology for the coming years, focusing particularly on those challenges best addressed collaboratively. Following a road-mapping exercise these challenges were captured in the European Metrology Research Programme (EMRP) (www.emrp.eu).

The aim of the Joint Research Project (JRP) "Nanotrace" here presented is National Metrology Institutes to collaborate in finding and testing new interferometric techniques to allow traceability of sensors and actuators at the nanoscale with a target accuracy better than 10 pm on a 10 to 100 um scale.

In the last two decades the invention and the development of scanning probe microscopy (SPM) has revolutionized the microscopic world science: scanning tunnel microscopy, atomic force microscopy and optical probe microscopy made possible observations and measurements with a resolution unthinkable before. The sub atomic resolution has made possible to observe the shape of molecules, the arrangement of atoms on a crystal, to study chemical reactions to the atomic level. The common principle of the SPMs, a probe tip scanning the surface in a 3 coordinate cartesian system, allows the realization of SPMs with integrated metrology system to obtain traceable measurements. Most NMIs have their own metrological SPM equipped with high resolution optical interferometer. The weak point is that the resolution of the SPMs is at least one order of magnitude smaller than the accuracy of the best interferometer available today.

There is no doubt that today the interferometer is the best choice for length measurement traceability: in fact interferometric measurement is based on the wavelength of a stabilized laser source which in turn is directly linked to the definition of the metre through frequency measurement. In its classic use (length measurements from millimetres to kilometres) the uncertainty of interferometric measurements is mainly limited by the knowledge of air refractive index and by laser frequency stability. When used for measurements down to the nanometre level, the interferometer fringe (being hundreds of nanometers long) must be subdivided in small equal parts. This measurement (which in fact is a phase measurement) is not straightforward.

To improve the resolution/accuracy of optical interferometers beyond the state of the art, allowing traceability of measurements at the nanoscale is the goal of this JRP. The target accuracy of 10 pm will allow to fill the gap existing between the resolution of existing measurement devices and the accuracy of the present metrology systems.

One of the possible traceability routes at the nanoscale is the use of crystalline surfaces and artificial arrangements of single atoms and nanotubes as standards for calibration or as base for new sensors. After some discussion it came out that, though the research in this field is proceeding fast, it is sill to young to be competitive with interferometers in the next future. Rather, it is believed that the realization of more accurate interferometer will accelerate the development of this promising research field.

Besides management (WP1) and dissemination (WP6), the project is divided into the following WPs:

WP2: Development of new interferometric techniques to minimize measurement uncertainty at the nanoscale.

WP3: Realization of a transfer standard with extreme metrological capabilities to allow the comparison between the interferometers that cannot be moved from a laboratory to another. Two ways will be investigated: a calibrated piezo-capacitive actuator, a compact interferometer or a combination of the two.

WP4: X-ray interferometer set-up to allow its use for the characterization of the interferometers developed in WP2.

WP5: Comparison (directly for transportable interferometers or indirectly by means of the transportable standard developed in WP3 for non transportable ones) with the X-ray interferometer developed in WP4, allowing a reliable evaluation of the results.

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