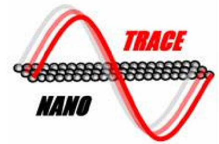


Publishable JRP Summary for T3 J1.4 NANOTRACE.

New Traceability Routes for Nanometrology

The project aims to 10 pm accuracy of displacement metrology namely by refined optical interferometry. The challenge is an uncertainty reduction of one order of magnitude with respect to the present state of the art.

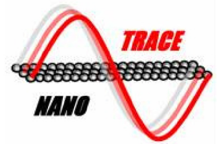
Dimensional measurements play a crucial role in almost every aspects of modern life, which is facing a growing role of ICT and nanotechnologies. For the metrology in semiconductor manufacturing laser interferometers are today essential for pattern placement measurements on photomasks and for position control in wafer scanners. Especially due to the use of double patterning techniques the accuracy demands of dimensional measurements are fastly growing. For mask metrology tools, a reproducibility of about 0.3 nm (3σ) is demanded in 2011. This means interferometer nonlinearities, noise and stability well below 0.1 nm will be necessary.
The project will provide a bridge between present state-of-the art of traceable displacement measurements by optical interferometers and future new ways and standards to provide traceability at the atomic scale.

Technical workpackages include the development of interferometric techniques, the realization of a transfer standard, the development of the x-ray interferometer and the comparison between the optical and x-ray interferometers to validate the targeted accuracy.

WP2 “**Development of new interferometric techniques**” will be articulated in 5 independent activities each one devoted to the realization and test of new interferometric techniques. Although the goal is the same (to minimize measurement uncertainty at the nanoscale) the techniques to be investigated exploit different technical solutions and/or physical principles. Each one is equally promising and has possible advantages with respect to the others. The pioneering level of the target requires a 360° investigation without an a priori choice of the “best” direction to go.

WP3 “**Realization of a transfer standard**” is a joint program to develop the device necessary to allow the comparison between the interferometers that cannot be moved from a laboratory to another. The device must have extreme metrological capabilities in order to minimize deterioration of the reference uncertainty. The best commercially available devices are definitely far from the accuracy needed for the comparison. The device will be also used for future development of precision interferometers.

WP4 “**x-ray interferometer set-up**” is a joint program to implement an existing x-ray interferometer in order to allow its use for the characterization of the interferometers developed in WP2. The x-ray interferometer, based on the Silicon crystal atomic lattice, has an intrinsic uncertainty to the picometer level, thus is the ideal instrument to validate new interferometers.



The activities of WP2 to WP4 will be carried out during the first two years. Further improvements and refinements are possible during the third year.

WP5 "Comparison" is to compare each interferometer developed in WP2 directly (for transportable interferometers) or indirectly by means of the transfer standard (for non transportable interferometers) with the x-ray interferometer. The comparison will allow a reliable evaluation of the results. The activity of WP5 will be carried out during the third year.

The Key outcomes of the project are:

- new optical setups, phase measurement and combined interferometers for displacement measurements at the nanoscale;
- a transfer standard with the stability needed for the comparison;
- an x-ray interferometer suitable for direct comparison with optical interferometers;
- validated interferometers with an accuracy of 10 pm;
- publication of the "Guideline on use of interferometers for traceability at the nanoscale".

Project advancement to April '09

Regarding WP2: most interferometric techniques have been proven, the design of the interferometers are completed and most devices are under construction. In particular the dual wavelength interferometer is already operative and ready for the comparison.

Regarding WP3: the preferred configuration of the Transfer Standard has been defined and will be based on the multipass technique. The technical design and the choice of the components is in progress.

Regarding WP4: the x-ray interferometer has been completely re-designed and the new components are under construction. The configuration of the platform that will host the interferometers under test in the "comparison phase" has been extensively discussed among the partners, this caused a slight delay. The platform is at present under construction.

Regarding WP6 (dissemination): the location for seminar and Workshop on "High resolution interferometry for traceability at the nanoscale" (deliverable 6.3) has been chosen to be held in the Czech Republic in occasion of NanoScale 2010; two paper have been published in Meas. Sci. and Technol.

All technological deliverables (development of devices and experimental results) are on time, while some report are delayed. In particular reports about "Intellectual Property Strategy" and "Action Plan to implement IP strategy" are not completed yet.

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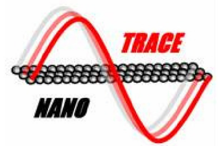

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JRP-Coordinator:

Name, Title, Organisation:	Marco Pisani, INRiM, Italy
Tel.:	+390113919961
E-mail:	m.pisani@inrim.it
JRP website address:	www.nanotrace.it

Other JRP partners:

Organisation, Country:
BEV, Austria
CMI, Czech Republic
MIKES, Finland
NPL, United Kingdom
PTB, Germany
UME, Turkey

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