

Metrology (on the nanometer scale) Nanometrology

<http://www.metas.ch/en/labors/3/35.html>: "Nanometrology is concerned with dimensional measurements of very small objects in micro, semi-conductor and nano technologies. The dimensions are typically given in nanometres (1nm = 1/1 000 000 mm), and the measurement uncertainty is often less than 1 nm. All the techniques employed are essentially microscope techniques used in conjunction with nano-positioning systems and high-precision position measurements."

National Institute for Standards and Measurements <http://www.ms1.nist.gov/Nanometrology.pdf>

"Nanotechnology will revolutionize and possibly revitalize many industries, leading to new and improved products based on materials having at least one dimension less than 100 nm. The federal government's role in realizing the full potential of nanotechnology is coordinated through the National Nanotechnology Initiative (NNI), a multi-agency, multi-disciplinary program that supports research and development, invests in a balanced infrastructure, and promotes education, knowledge diffusion, and commercialization in all aspects of nanoscale science, engineering, and technology.

NIST's unique and critical contribution to the NNI is *nanometrology*, defined as the science of measurement and/or a system of measures for nanoscale structures and systems. NIST nanometrology efforts focus on developing the *measurement infrastructure* —measurements, data, and standards — essential to advancing nanotechnology commercialization. This work provides the requisite metrology tools and techniques and transfers enabling measurement capabilities to the appropriate communities.

MSEL plays a vital role in nanometrology work at NIST with efforts in four of the seven NNI Program Component Areas — *Instrumentation Research, Metrology and Standards for Nanotechnology; Nanomaterials; Nanomanufacturing; and Fundamental Nanoscale Phenomena and Processes.*

National Physics Laboratory , U.K. <http://www.npl.co.uk/length/dmet/science/nanometrology.html>

its French Counterpart

http://www.lne.fr/en/r_and_d/nanometrology/nanometrology_objectives.shtml

its German counterpart <http://www.ptb.de/>



How to do metrology in general: see *An Introduction to Error Analysis, The Study of uncertainties in physical measurements*, 2nd edition, John R. Taylor

Nanometrology: Fundamental for Realizing Products at the Nanoscale

Michael T. Postek, National Institute of Standards and Technology, Gaithersburg, MD

“Advanced nanomanufacturing is important to the strength and growth of the U.S. manufacturing sector, and a strong measurements and standards infrastructure is vital for its success. Within the next 10 years, at least half of the newly designed advanced materials and manufacturing processes are predicted to be built at the nanoscale, and advanced measurement science (metrology) and instrumentation will be essential. If you cannot measure it you cannot make it. Successful metrology infrastructure is essential for manufacturers to achieve the real promise of newly developed nanomaterials, devices, and products. Instrumentation provides the data upon which sound scientific conclusions can be based, and correct metrology allows us to properly and accurately interpret those data. Together they facilitate nanomanufacturing.

Nanomanufacturing requires new process measurement and control systems that can span various size scales while accounting for the unique physics that governs the device and its interaction with the environment at each scale. In addition, nanomanufacturing must take into account that the nanoscale components have unique mechanical, electronic, magnetic, optical, and chemical properties that dominate their behavior and represent a scale of matter at which radically different phenomena are manifested. Measurements must determine where and when these unique properties begin to manifest. The success of nanomanufacturing will rely on a combination of theoretical (analytical and computational) and experimental tools that address predictability, producibility, and productivity in manufacturing at the nanoscale. Some aspects of nanomanufacturing will require novel manufacturing methods that deviate from the relentless scaling down of currently practiced technologies such as the semiconductor industry. “