Editorial

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Biographical notes: Wei Gao received his Bachelor in Precision Engineering from Shanghai Jiao Tong University, China, in 1986 and MS and PhD in Engineering from Tohoku University, Japan, in 1991 and 1994, respectively. He is currently Professor and Director of Research Center for Precision Nanosystems, Department of Nanomechanics of Tohoku University. His research interests include optical sensors, precision dimensional metrology and motion control. He acted as a Visiting Professor at the Center for Precision Metrology, University of North Carolina, Charlotte, in 1998. He is a member of JSPE, JSME, CIRP and a Fellow of the International Society for Nanomanufacturing. He is the author of the book *Precision Nanometrology – Sensors and Measuring Systems for Nanomanufacturing* published by Springer.

Richard Leach is a Principal Research Scientist at the National Physical Laboratory in the UK and a Visiting Professor at Loughborough University. He obtained his PhD in Surface Metrology from University of Warwick in 2000. He has been with NPL since 1990 and has current research interests in surface topography measurement, micro-coordinate metrology and computed tomography. He is on the Council of Euspen, the Board of MANCEF, the IoN Advisory Board and several international standards committees. He has over 140 publications including two textbooks. He is a Fellow of the Institute of Physics and the Institute of Nanotechnology.

Harald Bosse received his PhD in Physics from the University of Kassel in Germany in 1989 with a thesis on spinwave resonance characterisations of exchange coupled magnetic thin films. In 1990, he joined the PTB in Braunschweig, the Metrology Institute of Germany. Until 1995, he worked in the dimensional standards section and then moved to the PTB mask metrology section. In 1997, he was temporarily with the presidential staff section of the PTB before he took over responsibility for the length and angle metrology department in 2000. Since 2009, he is the Head of the PTB Precision Engineering Division.

Nanomanufacturing is a process that uses precision machines that can generate precision tool motions to fabricate designed surface forms/dimensions with nanometric tolerances. Dimensional measurement of the workpiece and the machine is always an essential process for the purpose of quality control in all kinds of manufacturing. Because accuracy is the most important requirement for nanomanufacturing, dimensional measurement is a far more crucial process in nanomanufacturing than in other kinds of manufacturing. In addition, more and more precision workpieces are required in a shorter amount of time in order to reduce manufacturing costs. The shapes of precision workpieces are also becoming more and more complex. These factors are bringing greater challenges in the areas of precision micro- and nano-metrology.

The aim of this special issue is to provide a forum for researchers and practitioners to present and review the state-of-the-art development of precision micro- and nano-metrology, and to identify directions for future research and development in related fields. Eleven papers have been accepted for publication in this special issue after careful reviews by multiple referees.

The first paper from Physikalisch-Technische Bundesanstalt (PTB) reports on recent achievements at PTB in the field of dimensional nano-metrology with a focus on instrumentation, measurement and simulation methods, and standards that are used in semiconductor lithography manufacturing – one of the important areas of nanomanufacturing. The PTB paper also provides a good review of the role of precision micro- and nano-metrology on nanomanufacturing. The second paper is related to length measurement, which forms the basis of precision micro- and nano-metrology. In this paper, Aketagawa et al. from Nagaoka University of Technology discuss the reduction of the measurement uncertainty in determination of the free spectral range (FSR) of a Fabry-Pérot cavity with the null method of using an electric-optic modulator, frequency modulation and the lock-in detection.

The third, fourth and fifth papers are related to optical metrology. You et al. from the Korea Advanced Institute of Science and Technology (KAIST) report the special-purpose design of a scanning white light interferometer for high-speed three-dimensional surface measurement of micro- and nano-patterned surfaces, in which parallel processing of fringe data is accomplished by adopting a graphics processing unit (GPU). Chen et al. from the National Taipei University of Technology present a new type of white light interferometry with a vibration-resistant capability achieved by in-situ optical detection and closed-loop feedback strategies. Hayashi et al. from Osaka University, present an optical microscopy system to trace changes in nanoparticle size, which allows evaluation of nanoparticle sizes over a wide range.

Contact-type dimensional metrology is described in the following two papers. Fan et al. from the National Taiwan University present design considerations of a precision

micro-CMM system and its mechatronic modules to meet the requirements of high stiffness, balanced forces, thermal balance, the Abbe principle, the metrology frame and vibration-reduction. Shimizu et al. from Tohoku University report on the fabrication of two types of micro-ball styluses, which are composed of a precision glass micro-ball and a shaft made by stainless steel or glass tubes.

The next three papers concern precision micro- and nano-metrology for ultra-precision machining, which is another important field of nanomanufacturing. Jang et al. from Tohoku University present the instrumentation of a measuring station based on an atomic force microscope (AFM), which is designed and constructed on a four-axis diamond turning machine for inspection of the cutting edge profile of single point diamond micro-tools. Kurokawa et al. from Kyushu University report on a micro-rotary encoder for measurement of the rotational motions of meshing micro-gears. In the paper by Ho and Cheung from the Hong Kong Polytechnic University, the surface generation in ultra-precision polishing is characterised by using power spectrum analysis based on the surface roughness measurement data.

The last paper, which is presented by Ito et al. from Shizuoka University, is focused on an electromagnetic probe for micro-manipulation and micro-metrology.

As guest editors, we believe that this special issue presents the newest information on precision micro- and nano-metrology from basic researches to applied systems for nanomanufacturing. We would like to thank all the authors for their great contributions to this special issue and the referees for their careful reviews of the papers. We would also like to express our thanks and appreciation to Professor Jack Luo and Professor Fengzhou Fang, editors-in-chief of *IJNM* for their kind offer of publication of this special issue.