JEMNÁ MECHANIKA A OPTIKA

VĚDECKO-TECHNICKÝ ČASOPIS
ROČNÍK 57 10/2012

OBSAH

Rozhovor s Ing. Ilonou Műllerovou, DrSc., ředitelkou Ústavu přístrojové techniky Akademie věd České republiky, v. v. i. v Brně *(O. Číp)* ... *263*

Elektronová mikroskopie v Ústavu přístrojové techniky AV ČR *(I. Müllerová, Z. Pokorná, L. Frank, Š. Mikmeková, E. Mikmeková)* ... *265*

Technologické využití elektronového svazku *(M. Zobač, J. Zobačová, I. Vlček)* ... *270*

Měření hmotnosti pomocí elektronového mikroskopu *(V. Krzyžánek)* ... *275*

RNDr. Jiří Keprt, DrSc. osmdesátníkem *(M. Hrabovský)* ... *277*

Nano modifikace hrotu W(100)/ZrO elektronového emitéru reaktivním iontovým leptáním *(M. Horáček, F. Matějka, V. Kolařík, M. Matějka, M. Urbánek)* ... *278*

Rastrovací elektronový mikroskop s rozlišením pod 1 nm *(F. Mika, A. Paták, L. Frank)* ... *281*

Laserový systém pro odměřování 3D polohy s nanometrovým rozlišením pro mikroskopy *(J. Lazar, J. Hrabina, M. Šerý, O. Číp, M. Čížek)* ... *283*

Mezinárodní konference LASER HELSINKI 2012 *(Z. Buchta)* ... *286*

Zlatá medaile MSV 2012 pro firmu MESING a Ústav přístrojové techniky Akademie věd ČR za „Automat pro bezkontaktní kontrolu délky koncových měrek" *(O. Číp)* ... *287*

Automatický systém pro bezkontaktní kalibraci koncových měrek *(Z. Buchta, M. Čížek, Š. Řeřucha, M. Šarbort, J. Lazar, O. Číp, P. Konečný, J. Kůr, R. Wíttek)* ... *289*

Charakterizace teplotní závislosti materiálů s nízkým teplotním koeficientem roztažnosti vhodných pro konstrukci nanometrologických mikroskopů *(O. Číp, R. Šmíd, M. Čížek, B. Mikel, J. Lazar, Z. Buchta)* ... *292*

Mezinárodní konference ISPEMI 2012 v Číně *(B. Mikel)* ... *295*

Bližší informace o poslání časopisu, pokyny pro autory, obsah časopisu apod. je uveden na internetu: ***http://jmo.fzu.cz/***

Informace o předplatném podá, objednávky přijímá, objednávky do zahraničí vyřizuje: SLO UP a FZÚ AV ČR, 17. listopadu 50, 772 07 Olomouc, tel.: 585 631 576, e-mail: eva.pelclova@upol.cz.

Cena čísla 40 Kč včetně DPH

FINE MECHANICS AND OPTICS

SCIENTIFIC-TECHNICAL JOURNAL
VOLUME 57 10/2012

CONTENTS

Interview with Ing. Ilona Műllerová, DrSc., director of the Institute of Scientific Instruments of the Academy of Sciences of Czech Republic, v. v. i. *(O. Číp)* ... *263*

Electron microscopy in the Institute of Scientific Instruments AS CR *(I. Müllerová, Z. Pokorná, L. Frank, Š. Mikmeková, E. Mikmeková)* ... *265*

Technological utilization of electron beams *(M. Zobač, J. Zobačová, I. Vlček)* ... *270*

Mass measurements using electron microscope *(V. Krzyžánek)* ... *275*

RNDr. Jiří Keprt, DrSc. celebrates his eighty *(M. Hrabovský)* ... *277*

Nano Modification of the W(100)/ZrO Electron Emitter Tip Using Reactive Ion Etching *(M. Horáček, F. Matějka, V. Kolařík, M. Matějka, M. Urbánek)* ... *278*

The scanning electron microscope with resolution below 1 nm *(F. Mika, A. Paták, L. Frank)* ... *281*

Laser system for measurement of the 3D position with nanometre resolution for microscopes *(J. Lazar, J. Hrabina, M. Šerý, O. Číp, M. Čížek)* ... *283*

International conference LASER HELSINKI 2012 *(Z. Buchta)* ... *286*

MESING and Institute of Scientific Instruments awarded with Gold Medal of International Engineering Fair 2012 for "Automatic system for contactless gauge blocks calibration" *(O. Číp)* ... *287*

Automatic system for contactless gauge blocks calibration *(Z. Buchta, M. Čížek, Š. Řeřucha, M. Šarbort, J. Lazar, O. Číp, P. Konečný, J. Kůr, R. Wíttek)* ... *289*

Characterization of thermal properties of materials with a low coefficient of thermal expansion suitable for the construction of nanometrological microscopes *(O. Číp, R. Šmíd, M. Čížek, B. Mikel, J. Lazar, Z. Buchta)* ... *292*

International conference ISPEMI 2012 in China *(B. Mikel)* ... *295*

For further information about the journal intention, instructions for authors, contents etc. please refer to ***http://jmo.fzu.cz/***

Information on subscription rate and on ordering gives the SLO UP a FZÚ AV ČR, 17. listopadu 50, 772 07 Olomouc, tel.: 585 631 576, e-mail: eva.pelclova@upol.cz.

Price for single copy: 40 Kč incl. VAT

CONTENTS

Interview with Ing. Ilona Műllerová, DrSc., director of the Institute of Scientific Instruments of the Academy of Sciences of Czech Republic, v. v. i. (O. Číp) 263

Electron microscopy in the Institute of Scientific Instruments AS CR (I. Müllerová, Z. Pokorná, L. Frank, Š. Mikmeková, E. Mikmeková) 265
Development of electron microscopes in the Institute of Scientific Instruments is overviewed from 1957 up to now. Recent results of the Group of scanning electron microscopy with slow electrons are presented in more details. The future of the development of electron microscopes is outlined.
Keywords: microscopy with slow electrons, crystallographic contrast, thin films, transmission electron microscopy, scanning electron microscopy

Technological utilization of electron beams (M. Zobač, J. Zobačová, I. Vlček) 270
The paper brings a brief overview of available technologies which utilize focused intense electron beam. In the introduction the principle of an electron gun is described and compared with cathode ray tube (CRT). Thereafter several technologies are mentioned, e.g. welding, machining, heat treatment, surface modification, engraving, texturing and additive manufacturing. The paper is concluded with a future outlook on electron beam technologies.

Mass measurements using electron microscope (V. Krzyžánek) 275
Scanning electron microscope (SEM) has been used for imaging and analysis of sample surfaces. However, a well calibrated SEM can also be used for quantitative measurements that are described in this contribution. We demonstrate that the extended SEM can be used for measurement of local thickness of very thin samples using an annular dark-field detector. Samples of interest for such measurements can be, for example, thin films, nanoparticles, macromolecular complexes where it is possible to measure mass per length in the case of filamentous structures or mass per area in case of layers. In addition, this technique can be applied to the absolute measurement without the need of any thickness or mass standards.

RNDr. Jiří Keprt, DrSc. celebrates his eighty (M. Hrabovský) 277

Nano Modification of the W(100)/ZrO Electron Emitter Tip Using Reactive Ion Etching (M. Horáček, F. Matějka, V. Kolařík, M. Matějka, M. Urbánek) 278
The W(100)/ZrO electron emitter tip is typically prepared from a tungsten single-crystal shaft of a diameter of 125 μm using electrochemical anodic etching. In order to prepare an emitter for e-beam writer with a shaped beam it is desirable to etch the tip with a radius around 100 nm. Despite the anodic etching is precisely controlled using dedicated software, the desired final form shape of the emitter tip is not achieved in every case. The correcting anodic etching is not possible due to the technology principle of the etching itself. We present in this contribution the procedure that modifies/repairs the tungsten tip shape in a nanoscale region using a reactive ion etching (RIE) in $CF_4 + O_2$ gaseous mix in a barrel type reactor at the radio frequency of 13,56 MHz and the working pressure of 1000 Pa. The change of the geometry after the RIE process is checked using a high resolution scanning electron microscope. The influence of the tip modification of the activated thermal-field W(100)/ZrO electron emitter on its emission characteristics is also presented.
Keywords: electron emitter, reactive ion etching, electron emission, thermal field, W(100)/ZrO

The scanning electron microscope with resolution below 1 nm (F. Mika, A. Paták, L. Frank) 281
The Institute of Scientific Instruments of the Academy of Sciences of the Czech Republic (ISI) in Brno has acquired a Magellan microscope, which belongs to the cutting edge in scanning electron microscopy. In the Czech Republic it is the first installation of this type. The American company FEI puts about 20 of them per year into operation worldwide. One of the FEI development and manufacturing centers is located in Brno. The microscope will serve not only to scientists from the ISI for basic and applied research, but it will also be available to colleagues from other institutes, universities and industrial companies.

Laser system for measurement of the 3D position with nanometre resolution for microscopes (J. Lazar, J. Hrabina, M. Šerý, O. Číp, M. Čížek) 283
Coordinate position sensing allows upgrading the imaging microscope techniques up to quantified measuring. Especially imaging techniques in the micro and nanoworld overcoming the barrier of resolution given by the wavelength of visible light are a suitable basis for design of measuring systems with the best resolution possible. Atomic force microscopy, other local probe techniques and electron microscopy when equipped with precision positioning and measurement of the probe and sample may become a tool for nanometrology – measurement of geometrical quantities on the nanoscale. Description of such a measuring and positioning system is a subject of this article.

International conference LASER HELSINKI 2012 (Z. Buchta) 286

MESING and Institute of Scientific Instruments awarded with Gold Medal of International Engineering Fair 2012 for "Automatic system for contactless gauge blocks calibration" (O. Číp) 287

Automatic system for contactless gauge blocks calibration (Z. Buchta, M. Čížek, Š. Řeřucha, M. Šarbort, J. Lazar, O. Číp, P. Konečný, J. Kůr, R. Wíttek) 289
In this paper, an automatic system for contactless gauge blocks calibration is presented. The system was developed in cooperation between Institute of Scientific Instruments of Academy of Sciences of the Czech Republic and Mesing spol. s r.o. Principle of the contactless gauge block calibration is based on a novel method combining broadband radiation and radiation of HeNe laser. The optical system is supplemented by automatic gauge block manipulator with capacity of 126 pieces of gauge blocks of length up to 100 mm. The device was awarded by a Gold Medal on International Engineering Fair hold in September 2012 in Brno.

Characterization of thermal properties of materials with a low coefficient of thermal expansion suitable for the construction of nanometrological microscopes (O. Číp, R. Šmíd, M. Čížek, B. Mikel, J. Lazar, Z. Buchta) 292
Recent special glass ceramics and special glasses belong to materials with low coefficient of thermal expansion. Their coefficient of thermal expansion for selected temperature ranges moves up to around zero. These materials are in great demand for the construction of frames and sub-parts of nano-positioning tables for metrological atomic force microscopes or electron microscopes that require excellent stability of the positioning table for one scan of the sample period. Samples produced low-expansion materials, however, they can often have the value of this coefficient very different, even within a single production run, which requires a determination of this parameter value before their intended use. In this paper we present a new measuring method which allows determining the thermal length expansion with a resolution below one tenth of a nanometer. Through the use of femtosecond optical frequency synthesizer we are able to measure changes in the range of lengths up to several micrometers.
Keywords: optical resonator, coefficient of thermal expansion, optical frequency synthesizer

International conference ISPEMI 2012 in China (B. Mikel) 295