

Measurement Science and Technology

Highlights of 2015

Editor-in-Chief: D J S Birch, Strathclyde University, UK



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Dear colleagues

I am delighted to present the *Measurement Science and Technology*[™] (MST) Highlights of 2015, a selection of the very best research published by the journal in 2015. These highlights show the tremendous diversity of areas covered by the journal. Articles in MST represent the highest quality research in measurement science, and are published following a rigorous peer-review process, which accepts fewer than one in three submissions to the journal.

The articles presented here have been selected by the journal's Editorial Board, with the guidance of our team of expert referees, as some of the highest quality papers we have published in 2015. I hope that you find them interesting.

To read the full-text articles, or to submit your own work to *Measurement Science and Technology*, please go to iopscience.org/mst. All these articles have been made free to read to the end of 2016.

Ian Forbes

Publisher, *Measurement Science and Technology*

Special issue papers

Development of fast response bi-luminophore pressure-sensitive paint by means of an inkjet printing technique

Y Egami, J Ueyama, S Furukawa, T Kameya, Y Matsuda, H Yamaguchi and T Niimi

Abstract

A novel fast response bi-luminophore pressure-sensitive paint (PSP) by inkjet printing of sensor-dot arrays on an anodized aluminum (AA) substrate has been developed for unsteady flow measurements. A bi-luminophore AA-PSP, which is a combination of PSP and temperature-sensitive paint (TSP), is essential for precise pressure measurements, because the PSP result needs the temperature correction. However, a conventional bi-luminophore AA-PSP prepared by a dipping method does not work well due to the interference between the PSP and TSP luminophores. To overcome this problem, we have developed isolated dot arrays of PSP and TSP formed on an anodized aluminum substrate by an inkjet printing method. In this study, platinum tetrakis (pentafluorophenyl) porphyrin (PtTFPP) and ZnS-AgInS₂ (ZAIS) were employed as pressure- and temperature-sensitive dyes, respectively. A suitable solvent was chosen for each dye to form the dots with uniform, high luminescence intensity, and high sensitivity. The developed bi-luminophore

AA-PSP could simultaneously measure pressure and temperature and could reduce the temperature effect of the PSP from $-0.97\%/K$ (without temperature correction) to $-0.01\%/K$ (with temperature correction). It showed a pressure response time of $17.8 \pm 0.8 \mu s$ at 90% pressure rise to a step change of pressure, which is in the same range as a conventional AA-PSP.

2015 *Meas. Sci. Technol.* **26** 064004

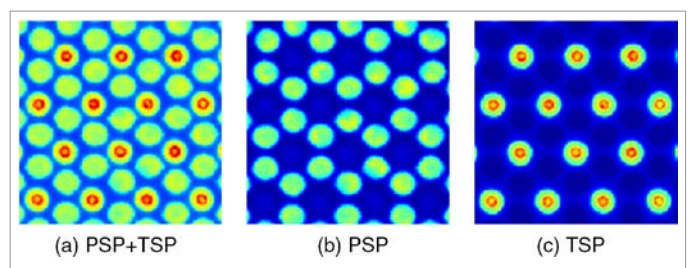


Figure taken from Y Egami et al 2015 *Meas. Sci. Technol.* **26** 064004



Did you know?

MST is the oldest measurement journal in the world, originally published as *Journal of Scientific Instruments* in 1923

Collaborative framework for PIV uncertainty quantification: the experimental database

Douglas R Neal, Andrea Sciacchitano, Barton L Smith and Fulvio Scarano

Abstract

The uncertainty quantification of particle image velocimetry (PIV) measurements has recently become a topic of great interest as shown by the recent appearance of several different methods within the past few years. These approaches have different working principles, merits and limitations, which have been speculated upon in subsequent studies. This paper reports a unique experiment that has been performed specifically to test the efficacy of PIV uncertainty methods. The case of a rectangular jet, as previously studied by Timmins *et al* (2012) and Wilson and Smith (2013b), is used. The novel aspect of the experiment is simultaneous velocity measurements using two different time-resolved PIV systems and a hot-wire anemometry (HWA) system. The first PIV system, called the PIV measurement system ('PIV-MS'), is intended for nominal measurements of which the uncertainty is to be evaluated. It is based on a single camera and features a dynamic velocity range (DVR) representative of typical PIV experiments. The second PIV system, called the 'PIV-HDR' (high dynamic range) system, features a significantly higher DVR obtained with a higher digital imaging resolution. The hot-wire is placed in close proximity to the PIV measurement domain. The three measurement systems were carefully set to simultaneously measure the flow velocity at the same time and location. The comparison between the PIV-HDR system and the HWA provides an estimate of the measurement precision of the reference velocity for evaluation of the instantaneous error in the measurement system. The discrepancy between the PIV-MS and the reference data provides the measurement error, which is later used to assess the different uncertainty quantification methods proposed in the literature. A detailed comparison of the uncertainty estimation methods based on the present datasets is presented in a second paper from Sciacchitano *et al* (2015). Furthermore, this database offers the potential to be used for comparison of the measurement accuracy of existing or newly developed PIV interrogation algorithms. The database is publicly available on the website.

2015 *Meas. Sci. Technol.* **26** 074003

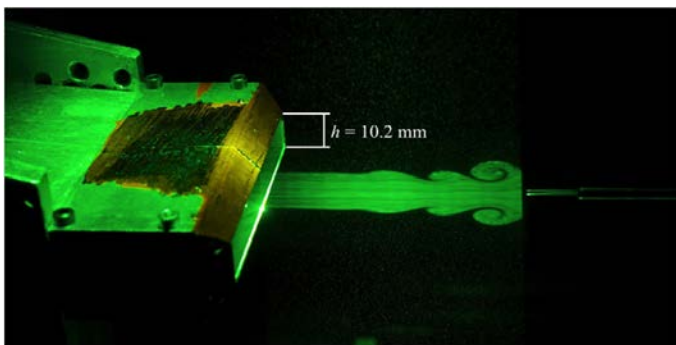


Figure taken from Douglas R Neal *et al* 2015 *Meas. Sci. Technol.* **26** 074003

Spectroscopically *in situ* traceable heterodyne frequency-scanning interferometry for distances up to 50 m

Günther Prellinger, Karl Meiners-Hagen and Florian Pollinger

Abstract

High-resolution saturation spectroscopy of iodine transitions at 637 nm is used to generate physically stable frequency reference markers for an interferometric absolute distance measurement based on frequency-scanning interferometry. Both experiments are performed simultaneously, posing severe challenges to the in principle well-established experimental techniques. The software-based enhancement of the signal-to-noise ratio is discussed in detail, as well as the demodulation and separation of the heterodyne interferometer signals. Verification measurements up to fifty meters indicate a relative measurement uncertainty well below 10^{-6} .

2015 *Meas. Sci. Technol.* **26** 084003

Impact evaluation of environmental and geometrical parasitic effects on high-precision position measurement of the LHC collimator jaws

Alessandro Danisi, Roberto Losito and Alessandro Masi

Abstract

Measuring the apertures of the Large Hadron Collider (LHC) collimators, as well as the positions of their axes, is a challenging task. The LHC collimators are equipped with high-precision linear position sensors, the linear variable differential transformers (LVDTs). The accuracy of such sensors is limited by the peculiar parasitic effect of being rather sensitive to external magnetic fields. A new type of inductive sensor, the Ironless Inductive Position Sensor (I2PS), that keeps the advantages of the LVDTs but is insensitive to external magnetic fields has been designed, constructed, and tested at CERN. For this sensor, a detailed description of parasitic effects such as high-frequency capacitances and the presence of conductive shields and electric motor, in the surroundings is given, from analytical, numerical, and experimental viewpoints. In addition, proof is given of the I2PS's radiation hardness. The aim of this paper is to give a complete and exhaustive impact evaluation, from the metrological viewpoint, of these parasitic effects on these two fundamental sensor solutions.

2015 *Meas. Sci. Technol.* **26** 094002

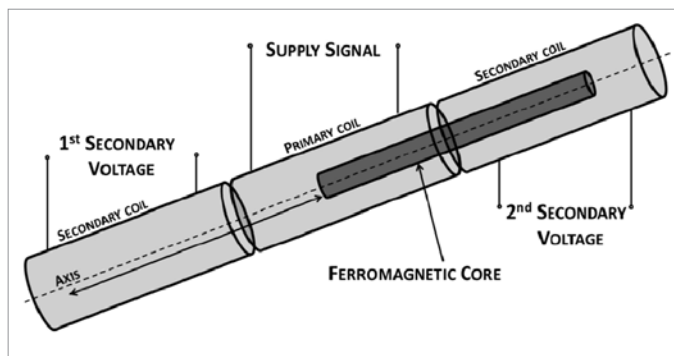


Figure taken from Alessandro Danisi *et al* 2015 *Meas. Sci. Technol.* **26** 094002



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Dynamic displacement measurement of a vibratory object using a terrestrial laser scanner

Kiyoung Kim and Junhee Kim

Abstract

Dynamic displacement measurement is often preferred over conventional acceleration measurement in the field of structural engineering. In this paper, a new methodology for dynamic displacement measurement using a terrestrial laser scanner (TLS) is presented. The methodology operates the TLS so as to measure multiple target points in a scan and to determine dynamic displacement from the distance data of the points. To lessen the TLS's inherent high noise contamination, optimal weighted averaging, i.e. the kriging method, is adopted, utilizing multiple neighbor points provided by TLS's spatial-temporal measurement. After conducting two experiments of vibration testing, it has been verified that the noise reduction efficiency of the proposed methodology does not change significantly with respect to the vibration characteristic of structures.

2015 *Meas. Sci. Technol.* **26** 045002

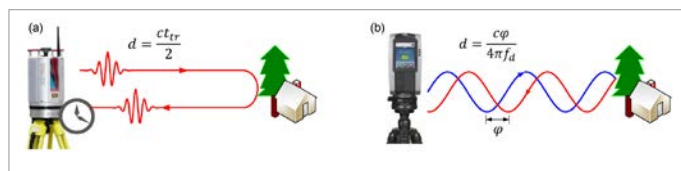


Figure taken from **Kiyoung Kim and Junhee Kim** 2015 *Meas. Sci. Technol.* **26** 045002

Traceable calibration of impedance heads and artificial mastoids

DA Scott, LP Dickinson and TJ Bell

Abstract

Artificial mastoids are devices which simulate the mechanical characteristics of the human head, and in particular of the bony structure behind the ear. They are an essential tool in the calibration of bone-conduction hearing aids and audiometers. With the emergence of different types of artificial mastoids in the market, and the realisation that the visco-elastic part of these instruments changes over time, the development of a method of traceable calibration of these devices without relying on commercial software has become important for national metrology institutes. This paper describes commercially available calibration methods, and the development of a traceable calibration method including the traceable calibration of the impedance head used to measure the mechanical impedance of the artificial mastoid.

2015 *Meas. Sci. Technol.* **26** 125013



Did you know?

MST's rigorous peer review process means that fewer than one in three papers submitted to the journal are accepted for publication

Network of flexible capacitive strain gauges for the reconstruction of surface strain

Jingzhe Wu, Chunhui Song, Hussam S Saleem, Austin Downey and Simon Laflamme

Abstract

Monitoring of surface strain on mesosurfaces is a difficult task, often impeded by the lack of scalability of conventional sensing systems. A solution is to deploy large networks of flexible strain gauges, a type of large area electronics. The authors have recently proposed a soft elastomeric capacitor (SEC) as an economical skin-type solution for large-scale deployment onto mesosurfaces. The sensing principle is based on a measurable change in the sensor's capacitance upon strain. In this paper, we study the performance of the sensor at reconstructing surface strain map and deflection shapes. A particular feature of the sensor is that it measures surface strain additively, because it is not utilized within a Wheatstone bridge configuration. An algorithm is proposed to decompose the additive in-plane strain measurements from the SEC into principal components. The algorithm consists of assuming a polynomial shape function, and deriving the strain based on Kirchhoff plate theory. A least-squares estimator (LSE) is used to minimize the error between the assumed model and the SEC signals after the enforcement of boundary conditions. Numerical simulations are conducted on a symmetric rectangular cantilever thin plate under symmetric and asymmetric static loads to demonstrate the accuracy and real-time applicability of the algorithm. The performance of the algorithm is further examined on an asymmetric cantilever laminated thin plate constituted with orthotropic materials mimicking a wind turbine blade, and subjected to a non-stationary wind load. Results from simulations show good performance of the algorithm at reconstructing the surface strain maps for both in-plane principal strain components, and that it can be applied in real time. However, its performance can be improved by strengthening assumptions on boundary conditions. The algorithm exhibits robustness in performance with respect to load and noise in signals, except when most of the sensors' signals are close to zero due to over-fitting from the LSE.

2015 *Meas. Sci. Technol.* **26** 055103

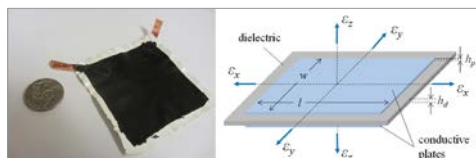


Figure taken from **Jingzhe Wu et al** 2015 *Meas. Sci. Technol.* **26** 055103

Ruthenium oxide ion selective thin-film electrodes for engine oil acidity monitoring

DK Maurya, A Sardarnejad and K Alameh

Abstract

We demonstrate the concept of a low-cost, rugged, miniaturized ion selective electrode (ISE) comprising a thin film RuO₂ on platinum sensing electrode deposited using RF magnetron sputtered in conjunction with an integrated Ag/AgCl and Ag reference electrodes for engine oil acidity monitoring. Model oil samples are produced by adding nitric acid into fresh fully synthetic engine oil and used for sensor evaluation. Experimental results show a linear potential-versus-acid-concentration response for nitric acid concentration between 0 (fresh oil) to 400 ppm, which demonstrate the accuracy of the RuO₂ sensor in real-time operation, making it attractive for use in cars and industrial engines.

2015 *Meas. Sci. Technol.* **26** 065102

2015 Outstanding Paper Award winner

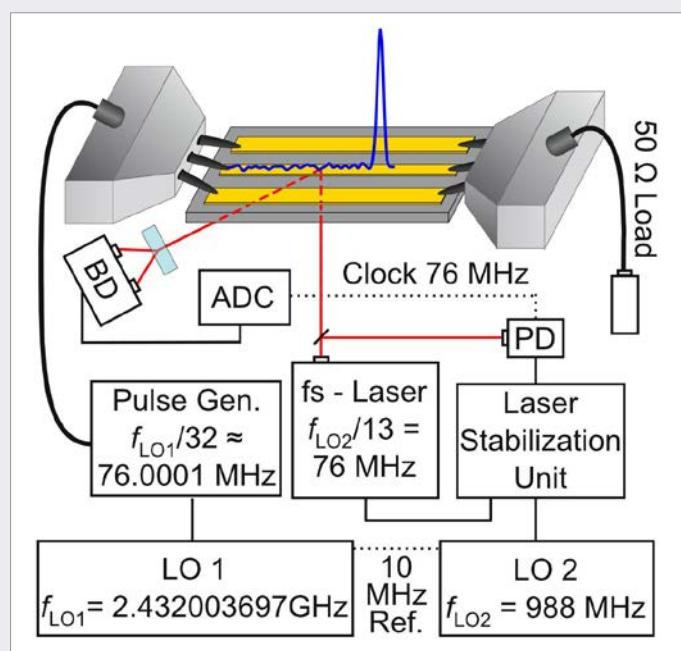
Optical and laser-based techniques

Asynchronous electro-optic sampling of all-electronically generated ultrashort voltage pulses

Heiko Füsler, Mark Bieler, Sajjad Ahmed and Frans Verbeyst

Abstract

We measure the output of an electrical pulse generator with a repetition rate of 76 MHz employing a laser-based asynchronous sampling technique with an effective sampling frequency of 250 GHz. A best estimate of the resulting 13 ns long waveform is obtained from multiple waveform measurements, which are taken without any trigger event and subsequently aligned in time. This asynchronous sampling scheme can even be adopted in situations where small phase drifts between the electrical pulse generator and the laser occur, making synchronized sampling very difficult. In addition to accurate measurements, the proposed asynchronous measurement scheme allows for the construction of covariance matrices with full rank since a large number of time traces is acquired. Such matrices might reveal correlations which do not appear in low-rank matrices. We believe that the asynchronous sampling technique advocated in this paper will prove to be a valuable characterization tool covering an ultra-broadband frequency range from below 100 MHz to above 100 GHz.

2015 *Meas. Sci. Technol.* **26** 025203Figure taken from Heiko Füsler et al 2015 *Meas. Sci. Technol.* **26** 025203**Deformation reconstruction of a smart Geogrid embedded with fiber Bragg grating sensors**

Zheng-fang Wang, Jing Wang, Qing-mei Sui, Lei Jia, Shu-cai Li, Xun-mei Liang and Shi-de Lu

Abstract

Due to the disadvantages of the current smart Geogrid for geotechnical use only being able measure strain and evaluate load location, a smart Geogrid embedded with fiber Bragg grating (FBG) sensors has been developed. Also, a deformation reconstruction technique has been investigated, which enables the newly designed smart Geogrid to evaluate the deformation fields of the key areas in geotechnical structures. After the fabricating process of the FBG embedded smart Geogrid was briefly introduced, a curvature information based deformation reconstruction method for the smart Geogrid was detailed. In order to optimize the distribution of the FBG nodes in the smart Geogrid, the finite element (FE) simulation data of the three possible causes of deformation were extracted, and the reconstruction results of the four distributions were compared. The results indicated that equidistantly distributed FBG sensors at the ribs of the smart Geogrid were the optimal distribution for the newly designed smart Geogrid. In addition, a modified deformation reconstruction technique was proposed to reduce reconstruction errors due to the stress concentration on the junctions of the smart Geogrid. The modified method, which employs FBG measured strains for calculating the deformation of the ribs and weighted strains to compute the coordinates of the two junctions, was validated by FE simulations. The simulation results illustrated that the modified method can improve the deformation reconstruction accuracy for both a Geogrid embedded with one fiber optic cable into one warp thread and a Geogrid embedded with multiple fiber optic cables in different warp threads. For the purpose of verifying the feasibility of the deformation measurements for the designed smart Geogrid using the proposed reconstruction techniques, experiments for the smart Geogrid embedded with one fiber optic cable were conducted in constant temperature environments. The curvatures of the smart Geogrid were calibrated prior to the deformation experiments in order to remove the errors induced by the strain measurement. The experimental results demonstrated that the reconstruction technique for the newly designed smart Geogrid was capable of evaluating the deformation field, and the modified reconstruction technique was able to effectively improve the reconstruction accuracy in order to fulfill the requirements of geotechnical usages. The newly developed smart Geosynthetic with deformation reconstruction techniques can be a promising smart Geosynthetic for the reinforcement as well as the monitoring of geotechnical engineering-related applications.

2015 *Meas. Sci. Technol.* **26** 125202**Dynamic range enhancement imaging in laser interferometry**

G Babaie, M Abolbashari and F Farahi

Abstract

In this paper, a novel technique to enhance the dynamic range of images acquired in a laser interferometer is presented. The irradiance of the interferometric signal received by the camera, in a Michelson interferometer, is controlled at pixel level using a spatial light modulator. It is shown that this technique increases the signal to noise ratio, hence improving the vertical resolution of interferometer systems.

2015 *Meas. Sci. Technol.* **26** 015202

Shock tunnel measurements of surface pressures in shock induced separated flow field using MEMS sensor array

R Sriram, S N Ram, G M Hegde, M M Nayak and G Jagadeesh

Abstract

Characterized not just by high Mach numbers, but also high flow total enthalpies—often accompanied by dissociation and ionization of flowing gas itself—the experimental simulation of hypersonic flows requires impulse facilities like shock tunnels. However, shock tunnel simulation imposes challenges and restrictions on the flow diagnostics, not just because of the possible extreme flow conditions, but also the short run times—typically around 1 ms. The development, calibration and application of fast response MEMS sensors for surface pressure measurements in IISc hypersonic shock tunnel HST-2, with a typical test time of 600 μ s, for the complex flow field of strong (impinging) shock boundary layer interaction with separation close to the leading edge, is delineated in this paper. For Mach numbers 5.96 (total enthalpy 1.3 MJ kg⁻¹) and 8.67 (total enthalpy 1.6 MJ kg⁻¹), surface pressures ranging from around 200 Pa to 50 000 Pa, in various regions of the flow field, are measured using the MEMS sensors. The measurements are found to compare well with the measurements using commercial sensors. It was possible to resolve important regions of the flow field involving significant spatial gradients of pressure, with a resolution of 5 data points within 12 mm in each MEMS array, which cannot be achieved with the other commercial sensors. In particular, MEMS sensors enabled the measurement of separation pressure (at Mach 8.67) near the leading edge and the sharply varying pressure in the reattachment zone.

2015 *Meas. Sci. Technol.* **26** 095301

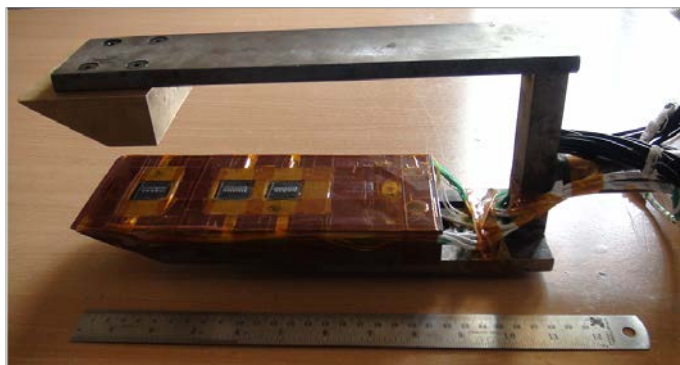


Figure taken from R Sriram et al 2015 *Meas. Sci. Technol.* **26** 095301

A mechanically stable laser diode speckle interferometer for surface contouring and displacement measurement

Daniel Francis, Dackson Masiyano, Jane Hodgkinson and Ralph P Tatam

Abstract

Electronic speckle pattern interferometry (ESPI) is demonstrated using a simple configuration consisting of a wedged window and a beamsplitter. The window serves to produce a reference beam which is in-line with the scattered object beam. The system is almost common-path and therefore provides much better mechanical stability than conventional ESPI configurations, which have widely separated beam paths. The configuration has collinear observation and illumination directions and therefore has maximum sensitivity to out-of-plane displacement. Wavelength modulation through adjustment of the laser diode control current provides a convenient method of phase shifting without the need for external moving parts. Further, variation of the laser diode control temperature allows extended wavelength tuning to adjacent longitudinal modes, facilitating surface contouring measurements via the two-wavelength technique. The interferometer is demonstrated for surface displacement measurement with a 3.3 μ m centre displacement measured over a 15 mm \times 15 mm region of a flat plate. Contour measurements of a shaped object are made using an equivalent wavelength of 1.38 mm.

2015 *Meas. Sci. Technol.* **26** 055402

Spectroscopy

Assessment of a fast electro-optical shutter for 1D spontaneous Raman scattering in flames

Hassan Ajrouche, Amath Lo, Pierre Vervisch and Armelle Cessou

Abstract

A critical aspect of 1D single-shot spontaneous Raman scattering (SRS) experiments in turbulent flames is the need to ensure highly efficient detection associated with fast temporal gating to remove flame emission. Back-illuminated CCD cameras are remarkable for their high quantum efficiency, large dynamic range, good spatial resolution and low readout noise. However, their full-frame architecture makes these detectors difficult to use for SRS measurements in flame and requires the development of a high-speed shutter. The present work proposes a fast electro-optical shutter composed of a large aperture Pockels cell placed between two crossed polarizers, providing high-speed gating up to 500 ns. The throughput of the shutter and its spatial homogeneity are measured. The angular tolerance of the Pockels cell is determined and its suitability for 1D probing is assessed. Spectra acquired in a premixed methane–air flame show the capacity of the shutter to remove flame emission and increase the signal-to-noise ratio for major Raman species.

2015 *Meas. Sci. Technol.* **26** 075501

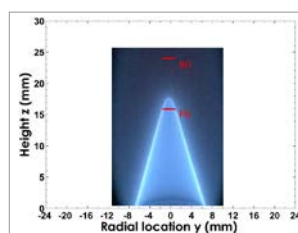


Figure taken from Hassan Ajrouche et al 2015 *Meas. Sci. Technol.* **26** 075501

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Non-ideal assembly of the driving unit affecting shape of load-displacement curves

Hu Huang and Hongwei Zhao

Abstract

The results of nanoindentation testing strongly rely on load-displacement curves, but an abnormal load-displacement curve with obvious inflection in the unloading portion was commonly observed in previously published papers and the reason is not clear. In this paper, possible reasons involved in a custom-made indentation instrument, such as sensors, control and assembly issues, are analyzed and discussed step by step. Experimental results indicate that non-ideal assembly of the precision driving unit strongly affects the shape of the load-displacement curve and its affecting mechanism is studied by theoretical analysis and finite element simulations. This paper reveals the reason leading to the abnormal load-displacement curve, which is helpful for debugging of indentation instruments and can enhance comparability of indentation results.

2015 *Meas. Sci. Technol.* **26** 035601

Lorentz force sismometry: a novel technique for measuring the electrical conductivity of solid and liquid metals

Shatha Alkhalil, Yurii Kolesnikov and André Thess

Abstract

In this paper, a novel method to measure the electrical conductivity of solid and molten metals is described. We term the method 'Lorentz force sismometry', where the term 'sismometry' refers to the letter sigma σ , often used to denote the electrical conductivity. The Lorentz force sismometry method is based on the phenomenon of eddy currents generation in a moving conductor exposed to a magnetic field. Based on Ampere's law, the eddy currents in turn generate a secondary magnetic field; as a result, the Lorentz force acts to brake the conductor. Owing to Newton's third law, a measurable force, which is equal to the Lorentz force and is directly proportional to the electrical conductivity of the conductive fluid or solid, acts on the magnet. We present the results of the measurements performed on solids along with the initial measurements on fluids with a eutectic alloy composition of Ga⁶⁷In^{20.5}Sn^{12.5}; detailed measurements on molten metals are still in progress and will be published in the future. We conducted a series of experiments and measured the properties of known electrical conductive metals, including aluminum and copper, to compute the calibration factor of the device, and then used the same calibration factor to estimate the unknown electrical conductivity of a brass bar. The predicted electrical conductivity of the brass bar was compared with the conductivity measured with a commercial device called 'SigmaTest'; the observed error was less than 0.5%.

2015 *Meas. Sci. Technol.* **26** 115605

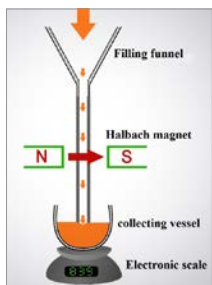


Figure taken from Shatha Alkhalil et al 2015 *Meas. Sci. Technol.* **26** 035601

2015 Outstanding Paper Award winner Biological, healthcare and life sciences

Rapid and accurate broadband absorption cross-section measurement of human bodies in a reverberation chamber

Ian D Flintoft, Gregory C R Melia, Martin P Robinson, John F Dawson and Andy C Marvin

Abstract

A measurement methodology for polarization and angle of incidence averaged electromagnetic absorption cross-section using a reverberation chamber is presented. The method is optimized for simultaneous rapid and accurate determination of average absorption cross-section over the frequency range 1–15 GHz, making it suitable for use in human absorption and exposure studies. The typical measurement time of the subject is about 8 min with a corresponding statistical uncertainty of about 3% in the measured absorption cross-section. The method is validated by comparing measurements on a spherical phantom with Mie series calculations. The efficacy of the method is demonstrated with measurements of the posture dependence of the absorption cross-section of a human subject and an investigation of the effects of clothing on the measured absorption which are important considerations for the practical design of experiments for studies on human subjects.

2015 *Meas. Sci. Technol.* **26** 065701

Instrumentation for environmental and atmospheric measurements

Combined GPS + BDS for short to long baseline RTK positioning

R Odolinski, P J G Teunissen and D Odijk

Abstract

The BeiDou Navigation Satellite System (BDS) has become fully operational in the Asia-Pacific region and it is of importance to evaluate what BDS brings when combined with the Global Positioning System (GPS). In this contribution we will look at the short, medium and long single-baseline real-time kinematic (RTK) positioning performance. Short baseline refers to when the distance between the two receivers is at most a few kilometers so that the relative slant ionospheric and tropospheric delays can be assumed absent, whereas with medium baseline we refer to when the uncertainty of these ionospheric delays can reliably be modeled as a function of the baseline length. With long baseline we refer to the necessity to parameterize the ionospheric delays and (wet) Zenith Tropospheric Delay (ZTD) as completely unknown. The GNSS real data are collected in Perth, Australia. It will be shown that combining the two systems allows for the use of higher than customary elevation cut-off angles. This can be of particular benefit in environments with restricted satellite visibility such as in open pit mines or urban canyons.

2015 *Meas. Sci. Technol.* **26** 045801

2015 Outstanding Paper Award winner

Measurement science

High-resolution velocimetry in energetic tidal currents using a convergent-beam acoustic Doppler profiler

Brian Sellar, Samuel Harding and Marshall Richmond

Abstract

An array of single-beam acoustic Doppler profilers has been developed for the high resolution measurement of three-dimensional tidal flow velocities and subsequently tested in an energetic tidal site. This configuration has been developed to increase spatial resolution of velocity measurements in comparison to conventional acoustic Doppler profilers (ADPs) which characteristically use divergent acoustic beams emanating from a single instrument. This is achieved using geometrically convergent acoustic beams creating a sample volume at the focal point of 0.03 m^3 . Away from the focal point, the array is also able to simultaneously reconstruct three-dimensional velocity components in a profile throughout the water column, and is referred to herein as a convergent-beam acoustic Doppler profiler (C-ADP). Mid-depth profiling is achieved through integration of the sensor platform with the operational commercial-scale Alstom 1 MW *DeepGen-IV* Tidal Turbine deployed at the European Marine Energy Center, Orkney Isles, UK. This proof-of-concept paper outlines the C-ADP system configuration and comparison to measurements provided by co-installed reference instrumentation. Comparison of C-ADP to standard divergent ADP (D-ADP) velocity measurements reveals a mean difference of 8 mm s^{-1} , standard deviation of 18 mm s^{-1} , and an order of magnitude reduction in realisable length scale. C-ADP focal point measurements compared to a proximal single-beam reference show peak cross-correlation coefficient of 0.96 over 4.0 s averaging period and a 47% reduction in Doppler noise. The dual functionality of the C-ADP as a profiling instrument with a high resolution focal point make this configuration a unique and valuable advancement in underwater velocimetry enabling improved quantification of flow turbulence. Since waves are simultaneously measured via profiled velocities, pressure measurements and surface detection, it is expected that derivatives of this system will be a powerful tool in wave-current interaction studies.

2015 *Meas. Sci. Technol.* **26** 085801

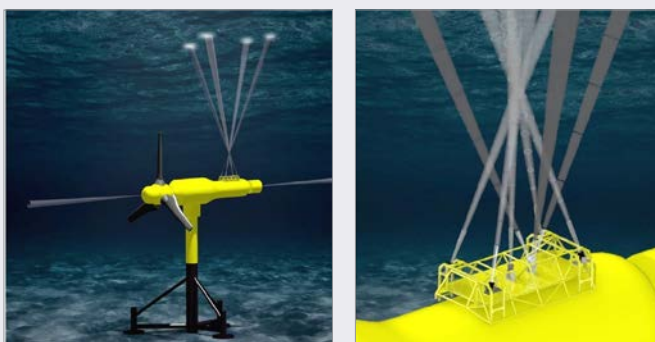


Figure taken from Brian Sellar et al 2015 *Meas. Sci. Technol.* **26** 085801

Did you know?

Papers to MST are currently accepted on average in three calendar months from receipt

Novel instrumentation

2015 Outstanding Paper Award winner

Sensors and sensing systems

Large carbon cluster thin film gauges for measuring aerodynamic heat transfer rates in hypersonic shock tunnels

S Srinath and K P J Reddy

Abstract

Different types of Large Carbon Cluster (LCC) layers are synthesized by a single-step pyrolysis technique at various ratios of precursor mixture. The aim is to develop a fast responsive and stable thermal gauge based on a LCC layer which has relatively good electrical conduction in order to use it in the hypersonic flow field. The thermoelectric property of the LCC layer has been studied. It is found that these carbon clusters are sensitive to temperature changes. Therefore suitable thermal gauges were developed for blunt cone bodies and were tested in hypersonic shock tunnels at a flow Mach number of 6.8 to measure aerodynamic heating. The LCC layer of this thermal gauge encounters high shear forces and a hostile environment for test duration in the range of a millisecond. The results are favorable to use large carbon clusters as a better sensor than a conventional platinum thin film gauge in view of fast responsiveness and stability.

2015 *Meas. Sci. Technol.* **26** 025901



Figure taken from S Srinath and K P J Reddy 2015 *Meas. Sci. Technol.* **26** 025901

Development of a high-resolution micro-torsion tester for measuring the shear modulus of metallic glass fibers

Y J Dai, Y Huan, M Gao, J Dong, W Liu, M X Pan, W H Wang and Z L Bi

Abstract

A high-resolution micro-torsion tester is developed based on electromagnetism, and the shear modulus of metallic glass fiber ($\text{Pd}_{40}\text{Cu}_{30}\text{Ni}_{10}\text{P}_{20}$) is measured using this tester. The torque is measured by a coil-magnet component and the rotation angle is measured by an inductive angular transducer. The calibration results show that the torque capacity of this tester is $1.1 \times 10^{-3} \text{ N m}$ with resolution of $3 \times 10^{-8} \text{ N m}$ and the rotation angle capacity is 90° with a resolution of 0.01° . A set of metallic glass fibers, with diameter of about $90 \mu\text{m}$, are tested using this tester. The average shear modulus is obtained as 20.2 GPa ($\pm 6\%$).

2015 *Meas. Sci. Technol.* **26** 025902

2D phase unwrapping algorithm for interferometric applications based on derivative Zernike polynomial fitting technique

Zixin Zhao, Hong Zhao, Lu Zhang, Fen Gao, Yuwei Qin and Hubing Du

Abstract

We propose a phase unwrapping method for general interferometric applications. The proposed method relies on a derivative Zernike polynomial fitting (DZPF) technique where the phase is approximated as a combination of Zernike polynomials. The fitting coefficients are then estimated using the least squares method. Thus the phase unwrapping problem is reduced to the calculation of these coefficients. Because of the full field operation, the proposed method is fast and efficient. In addition, the method directly provides the desired phase without the need to compute the misalignment errors further. The method combines the phase unwrapping and the wavefront fitting process. Simulation and experimental results are presented to validate the method's potential.

2015 *Meas. Sci. Technol.* **26** 017001

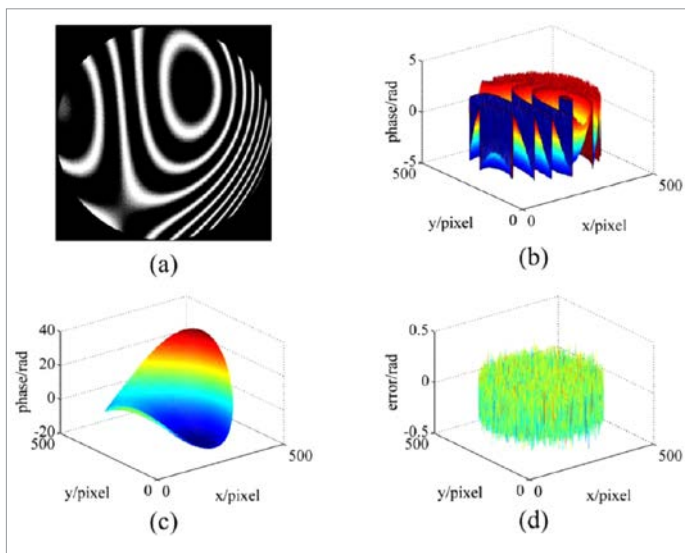


Figure taken from Zixin Zhao *et al* 2015 *Meas. Sci. Technol.* **26** 017001

Probing technique for localized thermal conductivity measurement

K Ziouche, Z Bougrioua, P Lejeune, T Lasri and D Leclercq

Abstract

A low-cost and non-destructive measurement technique based on the combination of a temperature sensor and a heater integrated in a very sharp tip is proposed for the determination of thermal conductivity of planar materials. The thermal sensor is fabricated by means of microtechnology technique. Associated to the system, an analytical thermal model is developed to express the measured Seebeck voltage as a function of the material thermal resistance. A numerical analysis based on COMSOL Multiphysics® is then developed to extract the thermal conductivity from the thermal resistance. To validate the approach proposed, experiments on planar dielectric materials and metals are conducted. Precision around $0.1 \text{ W m}^{-1} \text{ K}^{-1}$ for thermal conductivities lower than $2 \text{ W m}^{-1} \text{ K}^{-1}$ is obtained.

2015 *Meas. Sci. Technol.* **26** 087003

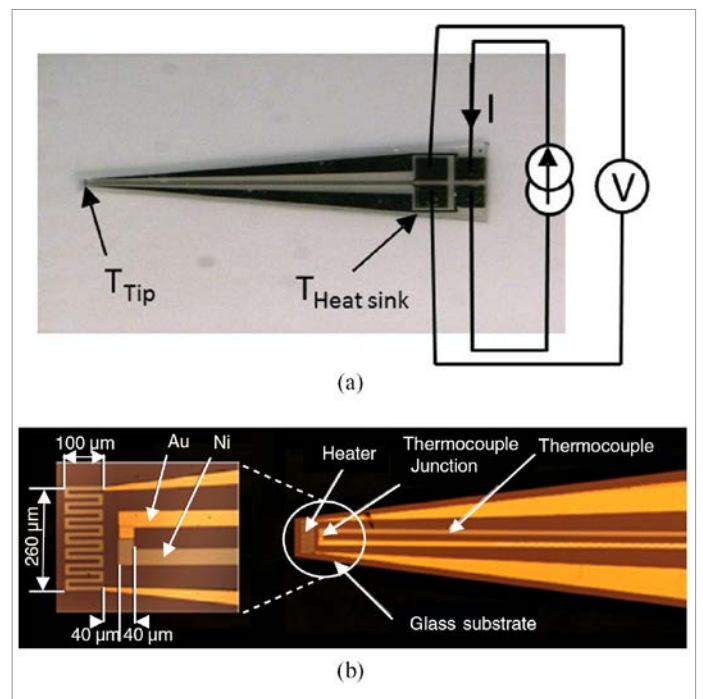


Figure taken from K Ziouche *et al* 2015 *Meas. Sci. Technol.* **26** 087003

2015 Topical Reviews

Measurement Science and Technology also publishes a programme of Topical Reviews, designed to report on recent progress in selected areas. In 2015, MST published the following reviews:

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Diagnostics for characterisation of plasma actuators

Marios Kotsonis 2015 *Meas. Sci. Technol.* **26** 092001

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