Editorial
Special Issue on Optical MEMS and Nanophotonics

I. INTRODUCTION

THE aim of PHOTONICS TECHNOLOGY LETTERS (PTL) is ultimately to serve the photonics community. As such, it is with great delight I would like to introduce the second Special Issue of PTL, in which we address the area of optical MEMS and nanophotonics, in response to a demand from the community. As with the inaugural Special Issue which appeared in November 2012, this Special Issue has been linked to an IEEE Photonics Society conference, this time the International Conference on Optical MEMS and Nanophotonics. The timescales for this Special Issue have been demanding and with this in mind, I would like to thank those who made rapid publication possible, namely the guest editors, authors, and anonymous reviewers for ensuring prompt reviewing, and Sylvia Flores and Eileen McGuinness for ensuring prompt production of the final manuscripts. I hope you will find this Special Issue of interest and hence, without further ado, I would like to hand over to the guest editors for the Special Issue on Optical MEMS and Nanophotonics and thank you for your continued readership.

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II. INTRODUCTION TO THE SPECIAL ISSUE

This past summer marked a special milestone, when the International Conference on Optical MEMS and Nanophotonics (OMN) celebrated its 20th year anniversary. What started out as an IEEE Lasers and Electro-Optics Society (now the IEEE Photonics Society) Summer Topical Meeting on the burgeoning field of Optical MEMS in Keystone, CO, USA, back in 1996, has established itself as a sustainable international conference with a dedicated following and an expanded scope. OMN prides itself in selecting attractive conference host sites in North America, Europe, and Asia-Pacific. This year’s conference—held in Jerusalem in August 2015—continued this tradition and drew participants from around the globe who enjoyed not only the scientific conference but also the city’s rich history, culture, and religious landmarks.

The conference featured plenary and invited speakers, as well as contributed papers and posters covering the many topics of interest to OMN, including MEMS materials and metasurfaces, optoelectronic and optomechanic devices, nanophotonics enabled devices from cavities to light enhancement in applications including spectroscopy, biophotonics, quantum information, and light-matter interaction. These latest reported research findings have demonstrated the widespread impact of photonics technology, addressing as well as enabling diverse scientific disciplines, both from a theoretical perspective and practical realizations. The full conference proceedings is available for download at the IEEE Xplore website, and can be found by searching the conference’s full name or following the link in [1].

All authors of OMN papers were encouraged to submit extended manuscripts of their work to this IEEE PHOTONICS TECHNOLOGY LETTERS Special Issue, and provided contributors the opportunity to publish their work in an archival journal with a long-standing reputation of excellence and high visibility. This Special Issue, which highlights recent progress on optical MEMS and nanophotonics, allowed authors to utilize PTL’s four-page letter format to expand the scope of reporting beyond that presented at the conference and introduce additional materials and new findings. Submissions were subject to the standard PTL peer-review process, to uphold the journal’s quality standards, ascertain the validity of the work, and ensure proper citations of previous work.

The 13 papers in this Special Issue cover the full range of topics from the OMN conference. One of the hallmarks of Optical MEMS is the ability to utilize mechanical actuation for interaction with light. Micromirrors for quasi-static pointing, active on–off modulation, or rapid scanning (operating at resonance) of light beams are common applications. In [2], MEMS micromirrors were used for line-of-sight indoor optical communication links for high bit rate communications from a centralized, ceiling-mounted, beam distribution system/hub to stationary stations, circumventing the need for wiring installation. A reflection modulator with a wide field-of-view used a cat’s-eye array reflector structure based on a movable concave mirror at each of the microlens arrays [3], whose state (i.e., on–off) can be read by remote illumination. A two-axis gimbaled mirror with large scan range was achieved by a special actuator design having out-of-plane comb structure [4], and used for imaging finger veins as part of an identity verification system. Micro-motion can also be applied to optical waveguides, for tunable photonics components. Large arrays of optical switches can be obtained by movable adiabatic couplers. In [5], an $N \times N$ crossbar switch in silicon photonics is demonstrated, with switching state of the $N^2$ switches...
being controlled by $2N$ electrodes. A conception for widely tuning the free-spectral-range of a racetrack resonator by splitting the circulating waveguide to two coupled parts is suggested in [6], although the actuation element has not been demonstrated yet.

Advanced micro-fabrication techniques enable new concepts in photonics. A photo-activated electrical modulator in silicon was obtained by shining light on the silicon device and creating free-electrons to control a gate voltage [7]. Lithium Niobate on silicon was processed by Argon ion-milling to create a rib waveguides and a microring resonator coupled to it [8]. The resonance wavelength can be electro-optically fine-tuned. A high-efficiency, resonance domain transmission diffraction grating and lens combination for visible light, fabricated by deep reactive ion etching into fused silica with a period of 520 nm, was used to realize a high resolution compact spectrometer [9].

Sensors using optical MEMS technology can enable unique functionality and high sensitivity. A fiber optic acoustic sensor at the fiber tip [10] enabled remote measurement of a membrane displacement. And a design of an uncooled THz imager has been proposed [11], based on wavelength selective surface tuned to the desired sensing frequency.

Finally, we would like to highlight some unique contributions. Slot waveguides yield high optical intensities within the slot which can serve as an optical driving force for suspended nanoscale waveguides. An analysis of the forces and displacements, taking into account the Casimir force between two electrically neutral and parallel conductive plates due to quantum fluctuations of the electromagnetic field was carried out in [12]. Imagine a window with built-in sunshades activated by a driving voltage. A prototype of such a MEMS window shade has been demonstrated consisting of small pixels, each with its own electrostatically activated roll-up shutters [13]. And a liquid lens which is focus-tunable is designed within a tubular structure, with the driving electrodes being first printed on a flexible polymeric foil that is then rolled and inserted into the tubular housing [14], simplifying the fabrication process. The lens focal length can be tuned from 8 mm to infinity, with low wavefront distortion.

It is our great hope that this Special Issue will be of great interest to researchers in the field and motivate additional researchers to get engaged within optical MEMS and nanophotonics research. We would like to extend to all interested researchers an invitation to attend the next OMN conference, to be held in Singapore, August 1–4, 2016.

The editors would like to thank the contributing authors for their submissions, the numerous reviewers for their careful and constructive criticism, and the IEEE publication staff, in particular Ms. Sylvia Flores, for their continuous support and follow-up to keep on schedule.
Dan M. Marom (S’97–M’00–SM’07) received the B.Sc. and M.Sc. degrees in mechanical and electrical engineering from Tel Aviv University, Israel, in 1989 and 1995, respectively, and the Ph.D. degree in electrical engineering from the University of California at San Diego (UCSD), in 2000. He is currently an Associate Professor with the Department of Applied Physics, Hebrew University, Jerusalem, Israel, heading the Photonic Devices Group.

He was a Member of the Technical Staff with Bell Laboratories, Lucent Technologies, from 2000 to 2005, where he invented and headed the research and development effort of MEMS-based wavelength-selective switching solutions for optical networks. Since 2005, he has been with Hebrew University, leading a research group pursuing his research interests in creating photonic devices and subsystems for switching and manipulating optical signals, in guided-wave and free-space optics solutions using light modulating devices, nonlinear optics, and compound materials. He has coauthored over 200 peer-reviewed journal and conference papers and holds 28 granted U.S. patents.

Prof. Marom is a Senior Member of the IEEE Photonics Society, and a Fellow of the Optical Society of America. From 1996 to 2000, he was a Fannie and John Hertz Foundation Graduate Fellow with UCSD, and a Peter Brojde Scholar from 2006 to 2007. He received the IEEE Photonics Society Distinguished Lecturer award for 2014 and 2015. He currently serves as Senior Editor for IEEE PHOTONICS TECHNOLOGY LETTERS, handling photonic devices related submissions.

Joseph Talghader (S’93–M’95–SM’08) received the B.S. degree in electrical engineering from Rice University. He was awarded an NSF Graduate Fellowship and attended the University of California at Berkeley, where he received the M.S. and Ph.D. degrees in 1993 and 1995, respectively. He worked at Texas Instruments as a Process Development Engineer, where he investigated EEPROM memory design and reliability issues. He joined Waferscale Integration in 1995, where he developed microfabrication processes for high-density nonvolatile memory devices. In 1997, he joined the faculty at the University of Minnesota as an Assistant Professor, and was later promoted to Associate and then Full Professor. He has been extensively involved in infrared and hyperspectral technologies, and optical coatings materials science. His group works in a number of different areas, including recent field work in Antarctica on the measurement of the optical properties of glacier ice. Dr. Talghader has received 3M Faculty Awards on three occasions. His technology has been a Finalist for the Minnesota Cup for entrepreneurs. He has served on various program committees and reviews, including service on the triennial strategic planning panel for the Army Research Office Electronics Division, twice as Program Chair and once as the General Chair of the IEEE/LEOS Optical Microelectromechanical Systems Conference. He has a long association with this conference as a Steering and Program Committee member and has served as an Editor of associated Special Journal issues on three occasions. He is a Subject Editor for the journal Light: Science and Applications (Nature Publishing Group).

Ming-Chang Lee (S’04–M’05) received the B.Sc. degree from National Chiao Tung University, in 1994, the M.Sc. degree from National Taiwan University, Taiwan, in 1996, and the Ph.D. degree in electrical engineering from the University of California at Los Angeles, USA, in 2005. He joined the faculty of the Institute of Photonics Technologies and the Department of Electrical Engineering, National Tsing Hua University (NTHU), Taiwan. From 1996 to 1998, he was with the Taiwan Semiconductor Manufacturing Company, Hsinchu, Taiwan, as a Supervisor in the Manufacturing Department. From 2006 to 2009, he was a Joint Professor with the Institute of NanoEngineering and MicroSystems, NTHU.

Prof. Lee is a pioneer in developing microelectromechanical system (MEMS) integrated photonic cavities. He has authored or coauthored over 100 peer-reviewed journal and conference papers, including one invited book chapter, and holds many patents in Taiwan and the U.S. His research interests include photonic MEMS, linear and nonlinear silicon photonics, high-speed Group IV optoelectronics, nanoplasmonic devices, and microfluidic photonics. He is a member of the Optical Society of America. He received the National Tsing Hua University Young Researcher Award in 2010, the 12th Far Eastern Y. Z. Hsu Science and Technology Paper Award, and the Young Optoelectronic Researcher Award in Taiwan. He served on the program committees of technical conferences, including CLEO, WOCC, CLEO Pacific Rim, and the IEEE Optical MEMS and Nanophotonics.