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OMN 2019 July 28-August 1 Daejeon, Korea

IEEE OMN 2019

2019 International Conference on Optical MEMS and Nanophotonics

| July 28 - August 1, 2019 | KAIST, Daejeon, Korea |

Welcome Message

It is my great honor and pleasure to invite you to the 2019 International Conference on Optical MEMS and Nanophotonics (IEEE OMN 2019), which will be held in Daejeon, Korea from July 28-August 1, 2019.

IEEE OMN 2019 will not only provide a comprehensive overview of the most recent developments in the field of Optical MEMS and Nanophotonics and the latest technologies and applications. With natural beauty and diverse tour attractions, the city of Daejoen will surely be the center of many unforgettable moments.

We look forward to welcoming you in Daejeon, Korea.

Sincerely yours,

Ki-Hun Jeong, Ph.D.

Prof. at KAIST, General Chair, IEEE OMN 2019

Keynote Speakers

The following visionary speakers will share their experience and insights on the latest trends and developments in the fields of Optical MEMS and Nanophotonics.

- **Prof. Dr. Hans Peter Herzig (EPFL, Switzerland)**
  "The Beauty of Micro-optics"
- **Prof. Olav Solgaard (Stanford University, USA)**
  "Micromechanical Phased Arrays"
- **Prof. Ming C. Wu (UC Berkeley, USA)**
  "Optoelectronic Tweezers - A New Optofluidic Platform for Digital Cell Biology"
- **Prof. Byoungho Lee (Seoul National University, Korea)**
  "Metasurfaces for Display and Imaging Applications"

Call for Papers

OMN 2019 welcomes original technology, science and application papers in the following areas:

Optical MEMS

- Optical Scanners and Micromirrors
- Micro-Optical Systems for Imaging
- Microactuators for Optical Devices
- Adaptive and Tunable Optics
- Telecommunications Devices
- Spatial Light Modulators

- Optofluidics
- Tunable Filters
- Microspectrometers
- Microphotonics
- Optical MEMS Sensors
- Cavity Optomechanics

- Optofluidics
- Tunable Filters
- Microspectrometers
- Microphotonics
- Optical MEMS Sensors
- Cavity Optomechanics

Nanophotonics

- Nanoplasmonics
- Metamaterials and Metasurfaces
- Nanophotonic Materials
- Nanofabrication
- Nanophotonic Displays
- Nanophotonic Storage
- Nanoparticles Photonic Devices

- Photonic NEMS
- Flatland Photonics
- Integrated Photonics
- Silicon Photonics
- Diamond Photonics
- Photonic Nanowires
- Waveguides

- Nanoscale Sources and Emitters
- Photonic Crystals
- Quantum Photonic Devices
- Quantum Dot Photonics
- Quantum Phenomena
- Nanoscale Light-Matter Interactions
- Nano-Biophotonics

Organized by The Society of Micro and Nano Systems

Technically Co-sponsored by IEEE Photonics Society, OSK Optical Society of Korea 30 Years

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Important Dates

Paper Submission System Open	Paper Submission Deadline	Early Bird Registration Deadline
February 18, 2019	May 10, 2019	July 5, 2019

Invited Speakers

Yasuhiko Arakawa (The University of Tokyo, Japan)
"Advances in Quantum Dot Lasers for Silicon Photonics"

Onur Ferhanoglu (Istanbul Technical University, Turkey)
"3D-printed Microsystems for Opto-medical Imaging"

Wayne Hiebert (National Institute of Nanotechnology/ National Research Council Canada, Canada)
"Damping is Good for You: Optomechanics for Mass Sensing"

Hartmut Hillmer (University of Kassel, Germany)
"Optical MEMS Based Micromirror Arrays: Fabrication, Characterization and Potential Applications in Smart Active Windows"

Jaeyoun Kim (Iowa State University, USA)
TBA

Jeong-bong Lee (UT Dallas , USA)
"Tunable and Flexible Nano Photonic Crystals"

Willie Luk (Sandia National Laboratories, USA)
"High Index Modulation Effects in Epsilon-near-zero Materials"

Kirsten Moselund (IBM Research, Switzerland)
"Monolithic Integration of III-V Microdisk Lasers on Silicon"

Raktim Sarma (Sandia National Laboratories, USA)
"Hybrid Dielectric and Plasmonic Metasurfaces : from Nonlinear Optics to Optoelectronics"

Tae Joon Seok (GIST, Korea)
"Silicon Photonics with MEMS for Efficient Light Manipulation"

Wei-Chuan Shih (University of Houston, USA)
"Multimodal and Multifunctional Plasmonic Nanostructures and Techniques"

Koji Sugano (Kobe University, Japan)
"Single-molecule Surface Enhanced Raman Spectroscopy Using Gold Nanoparticle Dimer"

Jian Ye (Shanghai Jiao Tong University, China)
TBA

Conference Venue: KAIST

The IEEE 2019 International Conference on Optical MEMS and Nanophotonics will take place in KAIST, the conference hall located in the 'Academic Cultural Complex' on KAIST Campus. The 'Academic Cultural Complex' provides an ideal setting for the conference presentations, the poster sessions and as well the standing lunch.

Committee

| General Chair
Ki-Hun Jeong (KAIST, Korea)

| Program Chair on Optical MEMS
Wibool Piyawattanametha (KMITL, Thailand)

| Program Chair on Nanophotonics
Kyoungsik Yu (KAIST, Korea)

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[P1-10] Ultrathin Digital Camera for High-contrast NIR Imaging

Kisoo Kim, Kyung-Won Jang, Sang-In Bae, and Ki-Hun Jeong

Korea Advanced Institute of Science and Technology, Korea

[P1-11] Transferable Silicon Nanowire Arrays Embedded in Flexible Polymer for Color Tuning with Metal Insulator Metal Structure

Yeong Jae Kim[1], Young Jin Yoo[1], Gil Ju Lee[1], Dong Eun Yoo[2], Dong Wook Lee[2], Vantari Siva[1], Hansung Song[1], Il Suk Kang[2], and Young Min Song[1]

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[P1-12] Otto Configuration Based Surface Plasmon Resonance with Tunable Air-gap Using Piezoactuator

Yeonsu Lee, Sung-min Sim, and Jung-Mu Kim

Chonbuk National University, Korea

[P1-13] Highly Doped Semiconductor Plasmonic Nanoantenna for Biomedical Sensing

Ahmed S. Abdeen, Ahmed M. Attyia, and Diaa Khalil

Electronics Research Institute, Egypt

[P1-14] Liquid Metal Based Flexible Microfluidic Device for Wireless Sensor Applications

Munirathinam Karthikeyan, Jongsung Park, and Dong-Weon Lee

Chonnam National University, Korea

[P1-15] An All-in-One FR4 Scanner Assembled with Optical Filters and a Photodetector for Very Low Cost Multiphoton Microscopes

Naitao Xu[1], Weiguo Liu[1], Jin Cheng[1], Qiliang Sun[2], Wen Bao[3], and Yingshun Xu[3]

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[P1-16] Development of an Active Reflector Using a Liquid Metal Droplet and Application of Endoscope to Increase Viewing Angle

Dong-Joon Won[1], Myoung Huh[2], and Joonwon Kim[1]

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Liquid metal based flexible microfluidic device for wireless sensor applications

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***Abstract*— Liquid metal enabled wearable technology provides a promising for flexible electronics. This paper reports a Galinstan based flexible microfluidic device for wireless applications. The microchannel is made on the PDMS substrate and the Galinstan as a conductive material is injected into the microfluidic channel to form the sensor circuit. The microfluidic device uses capacitive sensing principle for measuring the physical quantity and inductive coupling-based readout method for wireless communication of data and power. The flexibility of the device is characterized by fixing it on the human body and can be applied in the remote areas to accomplish wireless sensing platform. The device demonstration displays exceptional electrical stability under high human motions like wrist flexion, hand movement and finger bending without any fall in performance during mechanical degradation. We believe our microfluidic device provides a benchmark for flexible wearable electronics in wireless and remote sensing applications.**

Keywords—Galinstan, flexible microchannel, capacitive sensing, wireless communication

I. Introduction

Use of flexible electronics in the wearable device found a rapid increase in current MEMS technology for remote and biological wireless applications. So, the fabrication of flexible electronics become a hot topic for researchers, many fabrication techniques like liquid metal printing, microfluidic approach, selective plating and spray deposition were practiced, among this microfluidic approach is highly used in the flexible electronics. This approach mainly uses soft polymers polydimethylsiloxane (PDMS) with liquid metal to realize flexible electronics. Galinstan is the highly preferred liquid metal in current research because of its electromechanical properties like highly stretchable and bulk electrical conductivity. Several flexible electronics like diaphragm pressure sensor, stretchable biosensor, and inertial sensor realized for pressure monitoring, but capacitive pressure sensing in flexible microfluidics with readout method for wireless communication not reported much. Still, there are challenges in the fabrication and wireless sensing capabilities of flexible electronics.

Here, we propose a flexible microfluidic sensor based on PDMS multilayer microchannel with readout method for wireless communication. The flexible microfluidic capacitive sensor is designed based on the inductive capacitor circuit and fabricated by injecting Galinstan into the microfluidic channel. Liquid metal-based inductor coil and tunable capacitor of pressure sensor ensure the flexibility of the device by stretching according to the surrounding environment. The change in capacitance of the sensor detected by tag and is measured wirelessly by reader device using electromagnetic induction. The power for the senor is provided by the electromagnetic field of an active device in the proximity.

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II. Methods and Results

A. Working principle

The microfluidic channel is designed based on LC resonant circuit as sensing tag and readout method for wireless monitoring. Here, the change in capacitance with external pressure detected by external reader antenna using electromagnetic induction principle. Fig.1 shows the equivalent circuit of the wireless capacitive sensor, where the variable capacitor act as pressure sensing element, and sensor and reader antenna communicates through wireless technology. A PDMS made dielectric layer is sandwiched between the capacitor plates acts a deforming layer under external pressure reduce the resonant frequency of the LC resonator by changing the coupling capacitance of the capacitive sensor. The resonance frequency of the sensor measured by Impedance Analyzer readout method enables wireless operation through inductive coupling making the device battery-free by wireless powering.

B. Fabrication of flexible microfluidic device

Fig.2 shows the schematic of a microchannel formed on the PDMS substrate. The proposed wireless pressure sensor has three layers namely top, middle and bottom layer, where the top and the bottom layer, having similar microchannel. The microchannel is the connection of inductor coil and capacitor plates acting as sensor antenna and sensing element respectively. Top and bottom layer

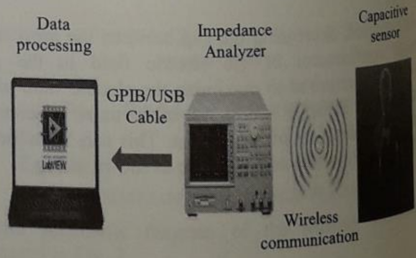

Fig. 1. Schematic of wireless capacitive sensing

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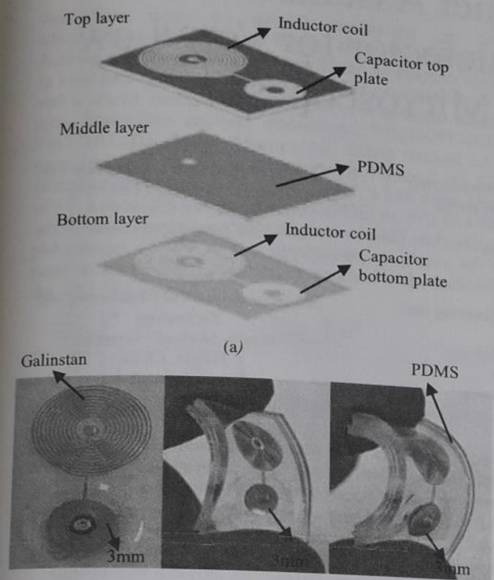

Fig. 2. (a) Schematic of PDMS microchannel fabrication. (b) Galinstan based flexible microfluidic device.

form LC resonant circuit and while middle layer acts as the dielectric layer between the capacitor plates. The microchannel fabrication is carried out using the soft lithography technique for all the three layers of PDMS substrate. After the microchannel fabrication, they are bonded together using oxygen plasma treatment. Then the Galinstan is injected into the microfluidic channel through the inlet using syringe manually. Liquid metal is injected using the syringe pump to measure the velocity. After injecting Galinstan the inlet and outlet of the device are closed using PDMS. Finally, the device is ready for the experimental study to analyze the characteristics of the pressure sensor.

c. Results

The wireless capacitive sensor uses inductive coupling-based readout technology for wireless communication of the devices in the proximity. Our wireless sensor has two parts: the LC circuit with a variable capacitor as sensing tag and a reader antenna, where the reader establish connection with the passive tag using inductive coupling. According to the influence of the external pressure, the capacitance of the sensor changes and the corresponding resonant frequency is measured by Impedance Analyzer. The Impedance Analyzer is used to measure the frequency sweep of the LC resonant circuit for the applied external pressure. Fig.3 shows the characterization of the sensor, where (a) represents the impedance response of the sensor for external pressure while (b) displays the variation of resonant frequency with respect to the pressure applied. Here the pressure of the range 0mmHg to 200mmHg at an interval of 20mmHg is applied and tested. Then the data is

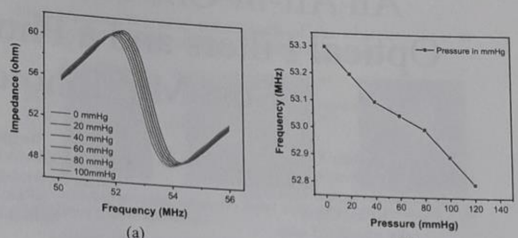

Fig. 3. (a) Characterization of capacitive sensor. (a, b) impedance response of the sensor for external pressure with 30mmHg and 40mmHg interval respectively.

processed and analyzed in MATLAB, connected to the analyzer through GPIB/USB cable. So, by measuring the resonant frequency of the sensor we can analyze the performance of the device.

III. Conclusion

Here, we propose a flexible wireless pressure sensor by injecting Galinstan into the microfluidic channels of the PDMS substrate. The effect of external pressure and strain on the electromechanical properties of the pressure sensor is characterized to study the flexibility of the microfluidic sensor. Since we use wireless communication, the sensor applied for remote measurements. Readout method is used for wireless monitoring and powering the passive tag. So, the data is be measured and processed using Impedance Analyzer and the microfluidic device is used for analyzing for various physical quantities.

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