



---

**The 8<sup>th</sup> Japan - China - Korea**  
**MEMS / NEMS**  
with NANO KOREA 2017

---

July 13-15, 2017, KINTEX, Korea

Hosted by



Organized by



Sponsored by



# :: Japan-China-Korea MEMS/NEMS with NANO KOREA 2017

## July 13th

Time	Program
	Nano/Micro Technology Leaders Forum
19:00- 20:00	Welcome Reception

## July 14th

Time	Session	Moderator	Program
08:00 ~ 08:30			Registration & Poster Setup
08:30 ~ 09:30	Oral Presentaion Session 1	Dr. Seunghoon Nam / KIMM	Dae Keun Choi / Seoultech, KITECH, Korea <i>"MEMS-BASED DRAG FORCE TYPE FLOWMETER FOR VEHICLE APPLICATION"</i>
			Seongbin Shin / The Univ. of Tokyo, Japan <i>"Hydrogen radical treatment for suppression of oxidation and contamination at copper surfaces"</i>
			Xu Du / Jilin Univ., China <i>"Synchronized oscillation in micro-mechanically coupled oscillator system - Part III: Synchronized region analysis with mass perturbation via coupled Cu-based cantilevers"</i>
			Sung-Won Youn / AIST, Japan <i>"Fabrication of a Holographic Pattern by UV-NIL Using PFP Gas"</i>
09:30 ~ 09:40			Break
09:40 ~ 09:50			Opening Remarks
09:50 ~ 10:20	Plenary Speech	Dr. Yeong-Eun Yoo / KIMM	Prof. Sunghoon Kwon / Seoul Nat'l Univ., Korea <i>"Rapid Antimicrobial Susceptibility Testing (RAST) for Expedite Treatment of Blood Stream Infection"</i>
10:20 ~ 10:40	Invited Talk 1	Dr. Yeong-Eun Yoo / KIMM	Prof. Dong F. Wang / Jilin Univ., China <i>"Passive DC Current Sensing: Forefront and Challenges"</i>
10:40 ~ 12:10	Oral Presentation Session 2	Dr. Kwanoh Kim / KIMM	Yuko Akabane / TDC Corp., Japan <i>"Precision polishing/lapping/grinding techniques contributing to MEMS and Nano technology"</i>
			Hidetoshi Takahashi / The Univ. of Tokyo, Japan <i>"Micro force plate for the measurement of total ground reaction force of running ants"</i>
			Liyi shi / Shanghai Univ., China <i>"Contemplations on the development of industrialization and commercialization of graphene in China"</i>
			Dae-Sung Kwon / Yonsei Univ., Korea <i>"Triboelectric energy harvester using curved flaps for multi-directional wind energy harvesting"</i>
			Ken Yoshinaga / Kyushu Univ., Japan <i>"The application of Micro Laser Doppler Velocimeter to hemodialysis"</i>
			Suganthi Selvakumar / Rajalakshmi Engineering College, India <i>"Functionalized Poly Di Methyl Siloxane (PDMS) for Micro-Fluidic based Capacitive Type Uric Acid Sensor"</i>
12:10 ~ 13:00			Luncheon
13:00 ~ 13:45	Poster Session		Poster Presentation

## A study of femtosecond laser controllable taper angle hole drilling with vibration

Wonsuk Choi<sup>1,2</sup>, Hoon-Young Kim<sup>1,2</sup>, Seok-Young Ji<sup>1,2</sup>, Young Gwan Shin<sup>1,2</sup>, Jin Woo Jeon<sup>2</sup>, Sanghoon Ahn<sup>2</sup>, Heeshin Kang<sup>2</sup>, Won Seok Chang<sup>1,2</sup>, Jaegu Kim<sup>1,2</sup>, Doo-Sun Choi<sup>2</sup>, Sung-Hak Cho<sup>1,2,\*</sup>

<sup>1</sup> Department of Nano-Mechatronics, Korea University of Science and Technology (UST)  
176 Gajung-dong, Yuseong-gu, Daejeon, 34113, KOREA

<sup>2</sup> Department of Laser & Electron Beam Application, Korea Institute of Machinery and Material (KIMM)  
171 Jang-dong, Yuseong-gu, Daejeon, 34103, KOREA  
Fax: +82-(42)-868-7431 E-mail address: shcho@kimm.re.kr

Fine Metal Masks (FMMs) used in the RGB evaporation process are an important component in high-resolution AMOLED manufacturing [1]. FMM is made of Invar alloy with low coefficient of thermal expansion, and it is made by chemical etching process. It is difficult to make hole diameter below thickness [2]. Femtosecond laser machining with less thermal damage to materials and precision machining is attracting attention because it requires a pattern smaller than the thickness of the FMM and requires adjustment of the taper angle of the pattern for high resolution AMOLED manufacturing. In this paper, we have studied the taper angle adjustment during femtosecond laser hole drilling using a vibrator.

The machining system consists of a femtosecond laser (Light conversion), beam delivery optics, a 3-axis stage, a coaxial illumination and vision, an objective lens, an oscillator, a function generator and an oscilloscope. The objective lens is attached to the vibrator so that the focus position is continuously changed by the signal input from the function generator.

Fig. 1 shows a Focused Ion Beam (FIB) cross-sectional image of the machined hole. The blue line represents the boundary between the Invar alloy and the platinum coating and represents the area of the platinum coated red circle. The change in the cross section of the hole can be known according to the amplitude change of the vibrator. Fig. 2 shows the definition of the taper angle and the graph of the calculated hole taper after varying the amplitude of the vibrator. The taper angle was calculated as inlet diameter, outlet diameter, and thickness. There was an error in machining and measurement, but the taper angle tended to increase as the amplitude of the vibrator increased.

In this paper, we show that the hole taper angle of  $31.8^\circ$  -  $43.9^\circ$  can be controlled by adjusting the amplitude of the oscillator using a femtosecond laser hole drilling system with a vibrator. It is expected that the taper angle of the hole tends to increase as the amplitude of the vibrator increases. This result is expected to be useful for FMM manufacturing and other nano / micro machining that require adjusting the taper angle while maintaining the hole size.

\*Corresponding Author: Sung-Hak Cho, Korea Institute of Machinery and Material (KIMM), KOREA, shcho@kimm.re.kr.