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## The 5<sup>th</sup> International Conference of Manufacturing Technology Engineers 2016

5 (Wed.) ~ 7 (Fri.) October 2016

RITZ-CARLTON HOTEL, SEOUL, KOREA

### Topics and Scope

- Advanced Machine Tools
- Robots and Automation
- IT/BT Fusion Systems
- Applied Optical Energy
- Ultraprecision Nanomachining
- Etc.
- Green Energy Application
- Printable Electronics
- Medical System
- Tool and Die
- Nano/Micro System
- Design and CAE
- Vibration and Control
- Green Manufacturing System
- Carbon Convergence
- Ocean Plant Manufacturing Technologies

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- Future Manufacturing Technology Innovation Toward the 4th Industrial Revolution



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## Oct. Oct. 6(Thu.) [Poster Session I ]

### Precision and Ultra-Precision Machining

- Silver Nanowire Network Ablation by a Femtoscond Laser ..... 28  
 Jin-Woo Jeon(Korea Institute of Machinery & Materials (KIMM)), Won-Suk Choi, Hoon-Young Kim  
 (Korea Institute of Machinery & Materials (KIMM), Univ. of Science & Technology (UST)), Hee-Shin Kang,  
 Jiyeon Choi, Sanghoon Ahn, Kyung-Hyun Whang, Jaegu Kim(Korea Institute of Machinery & Materials  
 (KIMM)), Daeyoon Kim(Univ. of Science & Technology (UST)), Sung-Hak Cho(Korea Institute of Machinery  
 & Materials (KIMM), Univ. of Science & Technology (UST))
- Ultra-precision Machining on Advanced Display Materials using a Femtosecond Laser ..... 29  
 Jin-Woo Jeon(Korea Institute of Machinery & Materials (KIMM)), Won-Suk Choi, Hoon-Young Kim  
 (Korea Institute of Machinery & Materials (KIMM), Univ. of Science & Technology (UST)),  
 Kyung-Hyun Whang, Jaegu Kim, Hee-Shin Kang, Jiyeon Choi, Sanghoon Ahn(Korea Institute of Machinery  
 & Materials (KIMM)), Daeyoon Kim(Univ. of Science & Technology (UST)), Sung-Hak Cho(Korea Institute  
 of Machinery & Materials (KIMM), Univ. of Science & Technology (UST))
- Ablation depth control on ITO-glass using beam shaped femtosecond laser ..... 30  
 Hoon-Young Kim, Won-Suk Choi(Korea Institute of Machinery & Materials (KIMM), Univ. of Science  
 & Technology (UST)), Jin-Woo Jeon, Da-Som Park(KIMM (Korea Institute of Machinery & Material)),  
 Sung-Hak Cho(Korea Institute of Machinery & Materials (KIMM))
- Low Cost and Energy Efficient Vibration Reduction of Ultra-Precision Manufacturing Machine ..... 31  
 Jihyun Lee(Korea Institute of Machinery & Materials), Chinedum E. Okwudire  
 (Univ. of Michigan - Ann Arbor)
- Measurement of the whole abrasive surface topography of a grinding wheel ..... 32  
 Chang-cai Cui, Qi-feng Yang, Yi-qi Yu(Institute of Manufacturing Engineering, Huaqiao University)
- Study on Grinding Characteristics of Different Crystal Surfaces of Sapphire ..... 33  
 Yi-Qing Yu, Ming-Jian Shao, Chang-Cai Cui, Zhong-Wei Hu, Xi-Peng Xu  
 (Institute of Manufacturing Engineering, Huaqiao University)

### Robot and Process Automation

- Development of Direct Preform Robot System for Laminated of Carbon Fiber ..... 34  
 Kee-Jin Park, Jin-Dae Kim(Daegu Mechatronics & Materials Institute),  
 Sung-Ho Yoon(Kumoh National Institute of Technology)
- A Robust Position and Velocity Control of Robot Manipulator with Eight D.O.F ..... 35  
 Min-Seong Kim, Chang-Bin Lee, Sang-Young Jo(Kyungnam Univ.), Jeong-Suk Kang, Nam-Il Yoon,  
 Jong-Bum Won(Smec Co., Ltd.), Sung-Hyun Han(Kyungnam Univ.)
- A Study on Robust Motion Control of Bipped Type Robot for Intelligent Manufacturing ..... 36  
 Dong-Yeon Jeong(Daeho Technology Korea Co., Ltd.), In-Man Park(Intem Co., Ltd.), Min-Seong Kim,  
 Sang-Young Jo, Sung-Hyun Han(Kyungnam Univ)
- A Study on Motion Control for Stable Walking of Bipped Robot ..... 37  
 Haeng-Bong Shin(SG servo Co., Ltd.), Woo-Song Lee(SungSanamdeco Co., Ltd.), Hyun-Suk Sim  
 (DongSan Tech Co., Ltd.), Sang-Young Jo, Sung-Hyun Han(Kyungnam Univ.)

[Poster Session I]

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# Silver Nanowire Network Ablation by a Femtosecond Laser

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*The reported study for silver nanowire network says it is a strong replacement due to its optical and electronic properties compare with ITO film and carbon nanotubes electrode. Moreover, mechanical property study about silver nanowire network indicates that it has great potential as transparent electrode.*

KEYWORDS : Silver nanowire, Femtosecond laser, Ablation, Micromachining

## 1. Introduction

There are candidates for thin transparent conductive electrode such as indium tin oxide film (ITO), conductive polymer, graphene, carbon nano tubes (CNTs), metal grid and metal nanowire network. ITO film, which is the most popular metal film for thin film electrode, is widely used due to its high electrical conductivity and transmittance in the visible wavelength range. ITO film, however, has critical issues due to ITO film disadvantage properties, brittleness, high sheet resistance, leaving aside cost, toxicity and scarcity of indium problems. Hence, the other candidates of transparent conductive electrodes have been studied. One of candidates replace to ITO film is silver nanowire networks for thin film applications.

## 2. Experiment

We fabricated the electrical isolation of silver nanowire network using a direct femtosecond laser (pulse duration : 380 fs) writing technique by employing tightly focused femtosecond laser. The lines are ablated at four kinds of pulse energy with six different stage scanning speed. The structured silver nanowire network is observed and evaluated by appropriate apparatus including optical microscope, atomic force microscope (AFM) and resistance measurement.

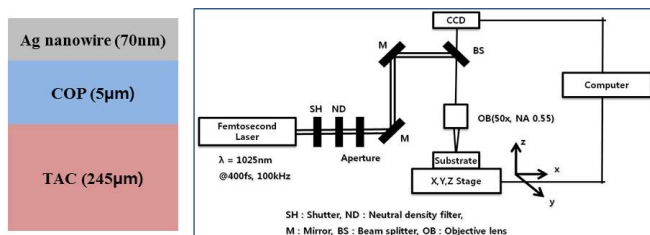


Fig. 1 The schematic pictures of the sample and system

## 3. Conclusions

We have demonstrated the electrical isolation of silver nanowire network on flexible substrate without damage to the bottom layer, TAC film, using tightly focused femtosecond laser. Eventually we have fabricated the electrical isolation square on the flexible silver nanowire network on flexible polymer substrate which has great possibility to use as an electrode of flexible display device. The results show the femtosecond laser system has potential as one of the solution for thin flexible layer patterning. Also compare to the traditional method for patterning electrode, femtosecond laser direct patterning can simplify the manufacturing process and reduce the environmental pollution. The experiment we have done would be useful data for further study and other research about flexible display device development.

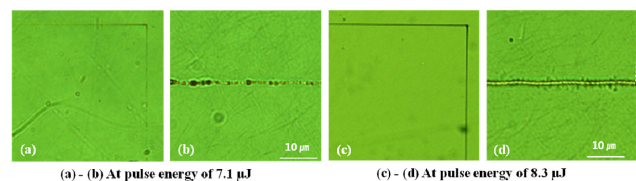


Fig. 2 Image of the ablation on the flexible silver nanowire network

## REFERENCES

[1] Tokuno T, Nogi M, Karakawa M, Jiu J, Nge TT, Aso Y, et al. Fabrication of silver nanowire transparent electrodes at room temperature. Nano Res 2011;4(12):1215–22.