SEUNGMAN CHOI

Technical Researcher

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RESEARCH INTERESTS

Ultra-precision engineering and metrology using femtosecond pulse laser

Detailed research topics include:

- Interpretation of light-matter nonlinear interaction, e.g. high harmonic generation and surface plasmon polariton.
- development of robust EUV light source with high photon flux.
- High-precision & ultrafast metrology via time-resolved EUV spectroscopy and coherent diffraction imaging.

RESEARCH PROJECTS

- **Ultrafast metrology using coherent EUV pulse** Aug 2021– Current

  We are now trying to devise time-resolved diffractive imaging system dealing with ultrafast metrology via EUV pump probe configuration. Measurable ultrafast dynamics could be given as following; localized surface plasmon resonances, thermal acoustic wave, absorption spectroscopy, pulse induced deformation. After narrowing down the scope of analyte requiring high spatio-temporal resolution, we will verify feasibility of EUV sub-femtosecond pulse from high harmonic generation for ultrafast metrology application.

- **Spatial EUV beam control** Sep 2020 – Aug 2021

  We demonstrated beam control schemes of coherent EUV based on high harmonic generation in solids without using any EUV optics and filters. EUV emitters exist along a single layer of the surface and therefore, through wavefront modulation of driving laser at sample surface, EUV focusing could be easily achieved and controlled. Moreover, we generated EUV Bessel beam by spatio-temporally overlapping annular shaped driving beams. Ptychographic wavefront retrieval revealed its focal spot ~400 nm and depth of focus ~1 mm. We are preparing for submission to journal.

- **Spectral EUV control & optimization** Apr 2019 – Aug 2020

  High harmonic generation enables for generated EUV pulse to preserve temporal and/or spectral characteristic of driving laser, while highly nonlinear propagation effect bring distortion into driving laser pulse. We demonstrated optimization scheme of driving laser field to actively control EUV pulse on the basis of genetic algorithm. By compensating the propagation effect in solid, we could achieve enhancement of EUV spectral yield up to an order of magnitude, selective suppression and cutoff extention in various materials. The study will be published in 2022.

- **Tunable droplet generation** Apr 2017 – Mar 2019

  We demonstrated a mechanically and directionally tunable elastic device that enable to actively control droplet breakup. In microfluidics, step emulsification has been attracting much attention; because it can easily scaleup the droplet formation based on its insensitivity to flow fluctuation. However, since its droplet formation is fully

geometry-dependent, active control for its size cannot be simply achieved by flow control. We envisioned a droplet generating system dealing with both mass production and size controllability, via soft materials allowing its nozzles' shrinkage and expansion. Applying tensile stress on the device, we changed the nozzles' geometry and accordingly tuned some degree of the droplet size. We are preparing for submission to journal.

- **Electrostatic gripper development** Apr 2016 – Mar 2017

  An electrostatic force-driven gripper with a structure of beam-array could offer sophisticated solution for gripping flexible materials due to its high applicability to targets with various size and arbitrary surface profile. However, it was also known that precise arrangement of multilayer electrodes demands high precision of manufacturing and limits its performance. We demonstrated simple alternate wet & dry etching process via a single photo-mask, which enable to process the multilayer thin films in the exactly same shape. The developed dipolar-electrostatic gripper was free from alignment problems and as a result, it displayed improved performance in terms of adhesive force. The study was published in 2018.

PUBLICATIONS

INTERNATIONAL JOURNALS

- **(In Preparation) "Opticsless Control of Extreme Ultraviolet Beam based on High Harmonic Generation from Solids."**
  B. Kim*, S. Choi*, Y. W. Kim, Y.-J. Kim and S.-W. Kim,
  *equally contributed to this work.
- **(In Preparation)** "**Soft Step Emulsification for Actively-tunable Droplet.**"
  S. Choi, N. Tottori, T. Nisisako

- "**Compensation of Laser Propagation Effects within Solids for High Harmonic Generation of Extreme Ultraviolet Radiation.**"
  Y.W. Kim*, B. Kim*, S. Choi*, H. K. Nam, H. Kim, Y.-J. Kim and S.-W. Kim,
  *equally contributed to this work.
  Optics & Laser Technology, 2022, 145: 107507.

- "**Development of Bipolar Electrostatic Chuck Module Having Array of Beam Assembly Using Lithography Technique**"
  S. Choi, K. Wakabayashi, S. Saito
  Journal of Micromechanics and Microengineering, 2018, 28.12: 125011.

DOMESTIC PATENT

- "**Micro Step-emulsification Device**"
  T. Nisisako, S. Choi and N. Tottori
  Application num.: 2018-036016, Patent num.: 2019-150748, JP.

INTERNATIONAL PROCEEDINGS

- "**High Harmonic Generation from Bulk Crystals using Tailored Driving Femtosecond Laser Pulse**"
  S. Choi, Y.W. Kim, B. Kim, H.K. Nam, Y.-J. Kim and S.-W. Kim
  2020 International Symposium on Precision Engineering and Sustainable Manufacturing ***(PRESM 2020)***, Online Symposium, Nov. 15-18, 2020.

- "**Mechanically and Directionally Tunable Soft Step Emulsification**"
  S. Choi, N. Tottori and T. Nisisako
  The 22nd International Conference on Miniaturized Systems for Chemistry and Life Sciences ***(MicroTAS2018)***, Kaohsiung, TW, Nov. 11-15, 2018.

- "**Development of Bipolar Electrostatic Chuck Module Having Array of Beam Assembly Using Lithography Technique**"

S. Choi, K. Wakabayashi and S. Saito
*2017 Materials Research Society Fall meeting (**MRS 2017**)*, Boston, MA, USA, Nov. 26-Dec 1, 2017.

- "**A Soft and Disposable Step-emulsification Device for Generating Monodisperse Emulsions and Particles**"
S. Choi, N. Tottori, R. Zhang and T. Nisisako
*The 7th International Conference of Asian Society for Precision Engineering and Nanotechnology (**ASPEN 2017**)*, Seoul, Korea, Nov. 14-17, 2017.

GRANTS & AWARDS

GRANTS

- **ITO Educational Foundation Scholarship** (JPY 180,000 per month) Apr 2017 – Mar 2019
ITO Foundation for International Education Exchange, JP.
- **Korea-Japan Join Government Scholarship** (JPY 130,000 per month) Apr 2013 – Mar 2017
Korea and Japan Government, KR&JP.
- **Foreign Tour Business Grant** (JPY 197,000 once) Aug 2018
*The Precise Measurement Technology Promotion Foundation (**PMTP-F**)*, JP.

AWARDS

- **Excellence Award** Feb 2019
*Korean Scientists and Engineers Association in Japan (**KSEAJ**)*, JP.
- **MutoEiji Award** Mar 2017
Academic Excellence Award in mechanical engineering department
*The Japan Society for Design Engineering (*JSDE*),* JP.

EDUCATIONAL BACKGROUND

- **M.S. in Mechanical Engineering** Apr 2017 – Mar 2019
Tokyo Institute of Technology, Tokyo, Japan
Thesis: Elastically deformable soft step emulsification for actively-tunable droplet.
Advisor: Prof. Takasi Nisisako
- **B.S. in Mechanical and Intelligent Systems Engineering** Apr 2013 – Mar 2017
Tokyo Institute of Technology, Tokyo, Japan (GPA 3.69/4.00)
magna Cum Laude in 4 years (Top 10%)
Thesis: Development of bipolar electrostatic chuck module having array of beam assembly using lithography technique.
Advisor: Prof. Shigeki Saito
- **Preparatory Education** (**Korea-Japan Joint Government Scholarship Program)** Apr 2012 – Mar 2013
Kyunghee University and Tokyo Institute of Technology
Study about japanese, basic physics and mathematics for 6 months at each institute.