Mahsa Torfeh

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Education

Ph.D. (Continued) in Electrical Eng. - Optics and Photonics *Aug 2021 - Present*
University of Southern California (USC)

M.Sc. and Ph.D. in Electrical Eng. - Optics and Photonics (Continued at USC) *Sep 2017 - Aug 2021*
University of Massachusetts Amherst

B.Sc. in Electrical Eng. - Communication Engineering *Sep 2012 - May 2017*
University of Tehran

Working Experiences

Meta (Facebook) - Research Intern *Dec 2023 - Feb 2024*
- Prospective intern

Samsung Semiconductor Inc. – MetaVisionLab (MVL) - Research Intern *Jun - Aug 2023*
- Inverse design and optimization of cascaded optical nano-structures
- Development of theoretical basis for polarization control using metasurfaces
- Providing three disclosures

Samsung Semiconductor Inc. – MetaVisionLab (MVL) - Research Intern *May - Aug 2022*
- Inverse design of optical metagratings
- Development of a new optimization method for optimally efficient optical metasurfaces
- Providing two disclosures based on the developed designs and methods

Awards and Honors

- SPIE Optics and Photonics Education Scholarship 2022
- Finalist at Meta PhD Fellowship 2022
- USC Ph.D. Fellowship Award 2021
- National Science Foundation (NSF): iREDEFINE Professional Development Award 2019
- First Place Poster Award (University of Massachusetts Amherst) 2019
- First Place Three-Minute (3MT) Presentation Award (University of Massachusetts Amherst) *2019*

Patents

- Siddique, R. H., **Torfeh, M.,** Fung, R., Wang, M., (Submitted from Samsung Semiconductor Inc.), (2022).
- Hsu, W., **Torfeh, M.**, Li, S., **"Integrating Lenses and Spaces for an Ultra-Compact Metasurface Imaging System"**, US provisional patent application 63/243,914, (2021).

Publications

- **Torfeh, M**. and Arbabi, A., **"Modeling metasurfaces using discrete-space impulse response technique"**. ACS Photonics, 2020.
- Einck, V., **Torfeh, M.**, McClung, A., Jung, D. E., Mansouree, M., Arbabi, A. and Watkins, J.J., **"Scalable Nanoimprint Lithography Process for Manufacturing Visible Metasurfaces Composed of High Aspect Ratio TiO2 Meta-atoms"**. ACS Photonics, 2021 (Accepted).

- McClung, A., Samudrala, S., **Torfeh, M.**, Mansouree, M. and Arbabi, A., **"Snapshot spectral imaging with parallel metasystems"**. Science Advances, 2020.
- Park, J., Hu, X., **Torfeh, M.**, Okoroanyanwu, U., Arbabi, A. and Watkins, J.J., **"Exceptional Electromagnetic Shielding Efficiency of Silver Coated Carbon Fiber Fabrics via Roll-to-Roll Spray Coating Process"**. Journal of Materials Chemistry C., 2020.
- Park, J., Hu, X., **Torfeh, M.**, Okoroanyanwu, U., Arbabi, A. and Watkins, J.J., **"Exceptional Electromagnetic Shielding Efficiency of Silver Coated Carbon Fiber Fabrics via Roll-to-Roll Spray Coating Process"**. Journal of Materials Chemistry C., 2020.
- Zou, K. et al., **"High-capacity free-space optical communicatins using wavelength and mode-division-multiplexing in the mid-infrared region"**. Nature Communications, 2022.
- Zou, K., et al., **"Demonstration of free-space 300-Gbit/s QPSK communications using both wavelength- and mode-division-multiplexing in the mid-IR",** Optical Fiber Communication Conference, 2022**.**

Conferences

- **Torfeh, M.**, McClung, A.C. and Arbabi, A., **"System-level models for metasurfaces"** (Conference Presentation). In Photonic and Phononic Properties of Engineered Nanostructures X. International Society for Optics and Photonics. 2020.
- **Torfeh, M.** and Arbabi, A., **"Analysis and design of metasurfaces using the discrete-space impulse response technique"** (Conference Presentation). In High Contrast Metastructures VIII. International Society for Optics and Photonics. 2019.
- McClung, A., **Torfeh**, **M.,** Einck, V., Watkins, J. J., Arbabi, A., **" Nanoimprint process for scalable manufacture of silicon nitride metalenses."** Conference Presentation). In High Contrast Metastructures IX. International Society for Optics and Photonics. 2022.
- McClung, A., **Torfeh, M.**, Mirzapourbeinekalaye, B., Mansouree, M., Samudrala, S. and Arbabi, A., **"Cascaded metasurface optics"** (Conference Presentation). In High Contrast Metastructures IX. International Society for Optics and Photonics. 2020.
- Einck, V., et al. **"Rapid direct nanoimprint lithography manufacturing of visible wavelength metalenses composed of high aspect ratio TiO2 nanoposts"** (Conference Presentation). In High Contrast Metastructures IX. International Society for Optics and Photonics. 2022.
- Einck, V., Watkins, J. J., Arbabi, A., McClung, A., **Torfeh, M.**, Mansouree, M., **"A scalable nanoimprint lithography process to manufacture diffractive optics and metalenses with high aspect ratio nanofeatures using high refractive index nanocrystals".** International Society for Optics and Photonics, 2021.
- Zou, K., et al. **"Demonstration of Free-Space 300-Gbit/s QPSK Communications Using Both Wavelength- and Mode-Division-Multiplexing in the Mid-IR."** 2021 Optical Fiber Communications Conference and Exhibition (OFC). IEEE, 2021.

Research Experiences

Photonics Laboratory, *University of Southern California* *2021-Present*

Developing a novel deep neural network system to optimally design multilayer metasurfaces

- Providing a novel neural network for inverse design of metasurfaces (Python, TensorFlow)
- Development of Mixture Density Network (MDN) as a new platform to solve the non-uniqueness issue in current machine learning inverse design methods

- Extending the modeling technique to optimally deign volumetric holography metasurfaces with high FoV and efficiencies applicable for AR devices.

Accurate modeling of angular responses of 3D metasurfaces and their integration

- Extending the developed modeling technique provided at USC group to accurately model arbitrary 3D optical metasurfaces with remarkable low computational costs using machine learning methods. (Python, TensorFlow)

Photonics Laboratory, *University of Massachusetts Amherst* *2017-2021*

Accurate modeling of angular responses of general metasurfaces

- Introducing a novel method for modeling general metasurfaces by planewave expansion of incident light reducing the modeling error by ~3x. (Linking MATLAB to S4 codes and COMSOL simulations)
- Modeling multi-layer metasystems using the proposed method
- Providing a new enhanced model using circuit models equivalent of the meta-atoms (MATLAB and S4 codes)

Design and implementation of a diffraction phase microscopy (DPM)

- Design and implementation of DPM for phase acquisition
- Preforming measurements and characterizations of 2D metalenses to provide accurate evaluations of the deformations in the fabrication.

Free space optics and integrated photonics measurement

- Implementation of measurement setups for free space optics and integrated photonics devices
- Measurement and characterization of various integrated photonic structures (Optical ring resonators and waveguide lenses)
- Measurement and characterization of 2D optical metalenses (Characterization of metalenses fabricated with nano-imprint lithography (NIL) to optimize the NIL process)

Development, fabrication, and characterization of optical planar absorber

- Surface morphology and absorbing material optimization to enhance the absorbance
- Optimization of the development and etch process of SU8 to provide high absorbance
- Exploring absorption coefficient and film quality of different metals deposited on etched SU8 (AJA sputtering system and CHA-SE 600 E-beam Evaporator

Development of PECVD deposition recipe

- Development of various PECVD deposition recipes for deposition of aSi, Si3N4 and SiNO3 (STS Vision 310 PECVD)

Microwave material characterization of polymer composites

- Implementation of characterization setup with rectangular waveguides at C, X and Ku band (PNA)
- Design and implementation of a broadband characterization setup using coaxial cables (PNA)

Modeling polymer composites for high electromagnetic shielding effectiveness

- Homogenization models for periodic polymer composites (HFSS, COMSOL and MATLAB)
- Providing framework for fabrication of composites to deliver high electromagnetic shielding effectiveness.

Photonics Laboratory, *University of Tehran* *2016-2017*

Wideband energy harvesting rectenna at microwave frequencies

- Homogenization models for periodic polymer composites (HFSS, COMSOL and MATLAB)
- Design and implementation of wideband rectanna for energy harvesting systems at microwave frequencies (HFSS and Keysight ADS)

Integrated Circuits Laboratory, *University of Tehran* *2015*

Remote heartbeat sensing system

- Design and implementation of wireless sensor network using nRF24L01+ (LabView)

Computer Skills

Programing: Python, TensorFlow, Keras, MATLAB ,C++/ C
Optical design software: Lumerical, Zemax, OSLO, S4(RCWA)
Numerical methods: Beam-propagation method, AI-algorithms, Transmission line-method, plane wave expansion, non-local EM behaviors
Engineering software: LabView, AutoCAD
Circuit simulations: Keysight ADS, SPICE
Electromagnetic simulators: COMSOL, HFSS, CST

Technical Skills

Optical design and on-chip measurements: Free-space optics imaging and spectroscopy, Holographic imaging for meta-optic defect detection, Integrated Whispering Gallery Mode (WGM) characterization, Light absorber Characterization for Imaging application.

Nano fabrication: PECVD, E-beam Evaporation, Sputtering, RIE, E-beam lithography
Characterization: SEM, Ellipsometer, Profilometry, Haze measurements
Backend processing: Wire bonding, Dicing saw, Microwave characterization of absorber materials

Teaching Experiences

University of Tehran *2015-2017*

- **Antenna theory, Microwaves, Computer Networks**
  Responsible for designing and grading homework assignments and course projects.
  Responsible for discussion classes.

Volunteering activities

- Board member at Society of SPIE/Optica Students Chapter at USC

Professional Society Membership

OSA, SPIE, Optica