# Yuheng Chen

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## OBJECTIVE

4th year ECE Ph.D., seeking a summer full-time internship to apply machine learning and photonics/optics experience.

## EDUCATION

**Purdue University** | Advisor: Dr. Vladimir M. Shalaev, Dr. Alexandra Boltasseva West Lafayette, IN
**Ph.D.** in Electrical and Computer Engineering (with Ross Fellowship) 08/2021 ~ 05/2026
NanoML Team leader | President of IEEE Photonics Society Student Chapter | Ex-Vice President of SPIE Student Chapter

**University of Science and Technology of China (USTC)** Hefei, China
**M.S.** in Optical Engineering (Honor) 09/2018 ~ 06/2021

**Hohai University** Nanjing, China
**B.S.** in Mechanical and Automation Engineering (Honor) 09/2014 ~ 06/2018

## QUALIFICATIONS

**Programming:** Proficient in Python, PyTorch, TensorFlow, Java, JavaScript, C/C++, Matlab for machine learning, multimodal model, computer vision, image segmentation, data augmentation, regression analysis, quantum computation.

**Simulation & Design:** Lumerical, Comsol, KLayout, Zemax, LabVIEW, Ansys-FEA, SolidWorks, AutoCAD, Origin.

**Device fabrication:** 6 years of cleanroom experience in nanodevice prototype design and fabrication: process optimization, lithographing (EBL, UV exposure), etching (RIBE, IBE, ICP, wet etching), AFM/SEM/microscopy optical characterization.

## INDUSTRIAL EXPERIENCE

**KLA Corporation** | Milpitas, CA 05/2023 ~ 08/2023
Machine Learning Algorithm Engineer Intern Supervisors: Dr. Phillip Atkins, Dr. Jinchuan Shi

1. Neural network solution for KLA AcuShape# chip architecture software
- Developed neural network to realize geometry critical dimension (CD) and spectra prediction/validation for Samsung V-NAND devices, substituting RCWA numerical method in the design loop.
- Designed bidirectional-training networks to accomplish software library generation with an 80% smaller training dataset and better linearity performance.

2. Investigate effective device degree-of-freedom (DOF) reduction via generative AI
- Built up a variational autoencoder-based model to effectively reconstruct and sample large DOF geometry critical dimension (CD) of semiconductor devices into decreased DOF in compressed latent space.
- Perturbed compressed DOF CDs during high-quality spectra output regression optimization and decreased 70% of regression iterations/simulation resource usage.

**Xingyu Automotive Lighting Systems** | Changzhou, China 09/2017 ~ 05/2018
Optical Engineer Intern

High-pixel digital lighting unit design
- Applied 3D modeling and optical trace simulations to design high-pixel, independently adjustable LED light matrices.
- Developed customized lighting projection functions for driving assistance in BMW lighting system team.

## ACADEMIC EXPERIENCE

**Machine learning for semiconductor**

1. Authentication in chip encryption through deep engine-based processing of tampered optical responses
- Designed a RAPTOR (Residual, Attention-based Processing of Tampered Optical Response) discriminator for identifying adversarial tampering of an optical, physical unclonable function based on a random array of gold nanoparticles embedded in semiconductor packaging.

- Extracted features of gold nanoparticles from 1000 dark-field images in just 27 ms and verified their authenticity using RAPTOR in 80 ms with 97.6% accuracy under difficult adversarial tampering conditions.

(1) B. Wilson†, **Y. Chen†**, and A. V. Kildishev, et al, 'Authentication through residual attention-based processing of tampered optical responses', *Advanced Photonics*, 6(5), 056002-056002 (2024). [Paper] **(Patent in progress)**

(2) B. Wilson†, **Y. Chen†**, and A. V. Kildishev, et al, 'Machine learning assisted optical authentication of chip tampering', *SPIE Optics + Photonics, Metamaterials, Metadevices, and Metasystems Conference*, 13113-16 (2024).

(3) SPIE featured news on our work: 'AI-powered optical detection to thwart counterfeit chips, researchers developed a robust optical anticounterfeit method for semiconductor devices'. [News] **Reported/interviewed by over 20 media globally.**

**Inverse design / machine learning for device optimization** (with Microsoft, QuEra, and Oak Ridge National Lab)

1. Advancing photonic design with topological latent diffusion generative model

- Developed topology optimization (TO) based deep generative model: Topological Latent Diffusion Model (TLDM), to realize high-quality inverse design.
- Applied efficiency prediction model-embedded conditional U-net and demonstrated substantial efficiency improvement compared with state-of-the-art generative model benchmarks.

2. Variational neural annealing for latent polynomial unconstrained binary optimization (PUBO) in device design

- Mapped device optimization problem into latent PUBO energy model to enforce the combinatorial optimization problem to the data optimization problem.
- Introduced variational neural annealing implemented through recurrent neural networks (RNNs) to solve PUBO, significantly outperformed simulated annealing and quantum annealing on sampling time and device efficiency.

3. Multimodal model for prompt-guided integrated photonics design

- Utilized stable diffusion model for a device feature description text-device topology image multimodal dual-training.
- Combined with ChatGPT API with the packaged trained model to realize an interactive LLM-empowered prompt-guided photonics design interface.

(1) M. Bezick†, **Y. Chen†**, B. Wilson, A. V. Kildishev, V. M. Shalaev, and A. Boltasseva, 'Latent diffusion models for global optimization in inverse design', *Nature Communications*, in review.

(2) M. Bezick, B. Wilson, V. Iyer, **Y. Chen**, V. M. Shalaev, S. Kais, A. Boltasseva, and B. Lackey, 'Pearson-correlated variational neural annealing for latent PUBO optimization', *Advanced Optical Materials*, in review (invited).

(3) **Y. Chen**, M. Bezick, and V. M. Shalaev, et al, 'Advancing photonic design with topological latent diffusion generative model', *Optica Frontiers in Optics + Laser Science Conference* (2024).

(4) B. Wilson, **Y. Chen**, S. Kais, A. V. Kildishev, V. M. Shalaev, and A. Boltasseva, 'Empowering quantum 2.0 devices and approaches with machine learning', *Optica Quantum 2.0 Conference and Exhibition*, QTu2A.13 (2022). [Paper]

(5) **Y. Chen**, A. V. Kildishev, V. M. Shalaev, and A. Boltasseva, 'Generative models for photonics device design and optimization', in preparation.

**Nanophotonics and Nanofabrication of metasurface**

1. Integrated 2D semiconductor light-emitting devices with plasmonic nanostructures

- Realized first experimental transfer and emission characterization of 2D TMDs (Transition-metal dichalcogenides) on plasmonic nano-terrace morphology.
- Generated 12-fold light emission enhancement with flexible manipulation feature, LSPR (Localized surface plasmon resonance) enhancement mechanism verified through FDTD simulation.

2. Self-organized lithography-free nanodevice fabrication with tunable optical anisotropy

- Implemented lithography-free nanofabrication method as team leader, realizing 3-fold aspect ratio promotion in self-organized metal co-deposition ion etching.
- Demonstrated outstanding tunable optical anisotropy feature in polarization, fitting well with RCWA simulation.

(1) L. Mascaretti, **Y. Chen**, O. Henrotte, O. Yesilyurt, V. M. Shalaev, A. Naldoni, and A. Boltasseva, 'Designing metasurface for efficient solar energy conversion', *ACS Photonics*, 10(12), 4079-4103 (2023). [Paper]

(2) **Y. Chen**, H. Li, and Y. Liu, et al, 'Monolayer excitonic semiconductors integrated with Au quasi-periodic nanoterrace morphology on fused silica substrates for light-emitting devices', *ACS Applied Nano Materials*, 4, 84-93 (2021). [Paper]

(3) **Y. Chen**, M. Cai, H. Zang, H. Chen, S. Kroker, Y. Lu, Y. Liu, F. Frost, and Y. Hong, 'Optical anisotropy of self-organized gold quasi-blazed nanostructures based on a broad ion beam', *Applied Optics*, 60, 505-512 (2021). [Paper]

(4) **Y. Chen**, M. Cai, K. Qiu, and Y. Hong, 'Optical anisotropy of metal nanowire arrays on fused silica surface', *Proceedings of SPIE*, 114271N (2020). [Paper]