Rui Chen

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Rui Chen's research interest is in nanophotonics devices and systems, with extensive experience in the numerical study of light-matter interactions, designing integrated photonic components and meta-optics, nanofabrication, and testing. He is currently working with Prof. Juejun Hu in M.I.T and Prof. Arka Majumdar at UW on programmable integrated photonics and meta-optics using phase-change materials (PCMs).

Education

University of Washington (UW) Seattle, WA
Ph.D. in Electrical Engineering Sep 2020 – Mar 2025
- Cumulated GPA: 3.94/4.0
- Award for Scientific Achievement in Nano-Engineered Systems

Columbia University (CU) New York, NY
M.S in Electrical Engineering Aug 2018 - May 2020
- Cumulated GPA: 4.2/4.0, ranking top 5%
- EE MS Honors Program

Zhejiang University (ZJU) Hangzhou, CN
B.Eng in Opto-Electronics Information Science & Engineering Sep 2014 - Jun 2018
- Cumulated GPA: 3.6/4.0 Major GPA: 3.9/4.0, ranking top 10%
- Second Prize, ZJU Undergraduate Scholarship 2016-2017 academic year

Research Experience

Programmable integrated photonics using PCMs Jul 2020 – Mar 2025
Nano Optoelectronic Integrated System Engineering (NOISE) Lab
Supervisor: Prof. Arka Majumdar *Seattle, WA*

Broadband non-volatile electrically controlled programmable units using $Ge_2Sb_2Te_5$ (GST)
- Designed programmable directional coupler switches with GST in Lumerical
- Simulated the transient heat transfer of the doped silicon PIN diode heaters in COMSOL
- Created a GDSPY library for fast drawing of GDSII-type files for lithography
- Fabricated several chips in the Washington Nanofabrication Facility (WNF)
- Characterized optical property and surface morphology of sputtered GST thin films using ellipsometry, X-ray diffraction (XRD), and atomic force microscope (AFM)
- Characterized the devices with a LabView-controlled vertical fiber coupling setup with an arbitrary function generator

Low-loss non-volatile silicon photonics using Antimony Sulfide (Sb_2S_3) with 5-bit operation
- Characterize Sb_2S_3 material optical property with ellipsometry
- Designed, fabricated, and characterized the low-loss programmable units using Sb_2S_3
- Showed reversible switching for more than 1,000 cycles with insertion loss less than 1.0 dB
- Discovered a novel multi-level operation (> 32 levels) by sending in near-identical electrical pulses
- Demonstrated the post-fabrication trimming of a balanced MZI using the 5-bit operation

Large-scale non-volatile electro-optical programmable gate array in the Intel 300-mm fab
- Optimized devices using GST, Sb_2S_3, and Antimony Selenide (Sb_2Se_3) compatible with Intel 300-mm silicon photonic fab
- Created a GDSPY library for fast tape-out of large-scale systems with Intel's design rules
- Developed post-fabrication methods to integrate PCMs on the Intel silicon photonic reticles
- Characterized individual devices with high endurance and performance
- Designed and fabricated architectures for large-scale, non-volatile switching fabrics, optical neural networks, and optical programmable gate arrays (OPGAs)
- Investigating packaging solutions for simultaneous electrical control of all the devices

Non-volatile phase modulation in individual pixel electrically controllable metasurface with Sb_2Se_3

- Designed the quasi-bound-state-in-the-continuum (q-BIC) metasurface in S4 and Lumerical RCWA
- Designed an angle-independent guided-mode resonance using Lumerical RCWA
- Simulated the free-space propagation after the metasurface using a home-built angular spectrum propagation method in Python
- Fabricated the individual pixel controllable metasurface
- Characterized the electrically reconfigurable optical spectrum in a transmissive near-infrared spectrometer setup
- Characterized the three-dimensional beam profile after the metasurface in a motorized stage setup

Photonic Integrated Circuits for High-Speed DataCom Nov 2018 – May 2020

Lightwave Research Laboratory

Supervisor: Prof. Keren Bergman *New York, NY*

Ultra Broadband Interleaver Design with Dispersion Engineering

- Designed a broadband 2-stage Ring-Assisted Mach-Zender Interferometer (RA-MZI) interleaver with dispersion engineering
- Optimized an interleaver-assisted 64×25Gb/s high-speed link based on American Institute of Manufacture (AIM) Photonics PDKs
- Drew the mask layout of the designed interleavers in AIM foundry using Cadence

Integrated Photonic Chip Testing & Characterization

- Built up a testing platform for chip alignment
- Measured experimentally the insertion loss and channel crosstalk of a polarization-insensitive photonic switch chip based on Switch-and-Select Topology fabricated in AIM Foundry
- Characterized the insertion loss and crosstalk of a 4 × 4 photonic switch based on the Hitless-Switch architecture fabricated in Elenion Technologies

Academic Experience

Serving as a **reviewer** for multiple scientific journals, including Microsystems & Nanoengineering, Advanced Materials, Advanced Functional Materials, Advanced Optical Materials, Laser & Photonics Reviews, Nanophotonics, ACS Photonics, New Journal of Physics, Optics Express, Optics Letters, Journal of Optics, Journal of Lightwave Technology, Optical Materials Express, Applied Optics, Journal of Nanophotonics, Photonics Technology Letters, Infrared Physics and Technology, Advanced Physics Research.

Postdoctoral Associate April 2025 – now
Massachusetts Institute of Technology, Prof. Juejun Hu Cambridge, MA

Research Assistant Aug 2020 – Mar 2025
University of Washington, Prof. Arka Majumdar Seattle, WA

Teaching Assistant, EE 535 Applied Nanophotonics Mar 2022 – Jun 2022
University of Washington, Prof. Arka Majumdar Seattle, WA

Teaching Assistant, EE 299 Intro to Nanotechnology Jan 2022 – Mar 2022
University of Washington, Prof. Arka Majumdar Seattle, WA

Teaching Assistant, EE 331 Devices and Circuits Mar 2021 – Jun 2021
University of Washington, Prof. Tai Chen Seattle, WA

Teaching Assistant, EE 233 Circuit Theory Jan 2021 – Mar 2021
University of Washington, Prof. Scott Dunham Seattle, WA

Teaching Assistant, EE 332 Devices and Circuits Sep 2020 – Dec 2020
University of Washington, Prof. Sajjad Moazeni Seattle, WA

Course Assistant, ELEN 3401 Electromagnetics Feb 2020 – Jun 2020
Columbia University, Prof. Keren Bergman New York, NY

Teaching Assistant, ELEN 4944 Principles of Microfabrication Aug 2019 – Dec 2019
Columbia University, Prof. Jacob Trevino New York, NY

Industrial Experience

Meta Platforms, Inc. (Meta) Redmond, WA
Intern Research Scientist Jul 2024 – Sep 2024
Manager: Dr. Zhujun Shi
- Develop understanding about the physics of the optical components
- Design and optimize novel optical components for usage in AR/VR

Professional Skills

Programming : Python, Java, C, C++, MATLAB, SystemVerilog
Design Tools : Lumerical, COMSOL, Zemax, S4 RCWA, CodeV, Cadence, RSoft, OptSim, Optodesigner
Experiment : Labview, optical spectrum analyzer (OSA), BER tester (BERT), TSL sweep laser, arbitrary function generator, Keithley source meter, near-infrared spectrometer (Princeton Instrument)

Publications

* corresponding author, † Equal contributor.

Submitted/in-press journal articles

[1]. Xiao, K., Tara, V., Reddy, P.D., Meyer, J.E., Skipper, A.M., **Chen, R.**, Nordin, L.J., Majumdar, A. and Mukherjee, K. (2025). *Heteroepitaxial growth of highly anisotropic Sb_2Se_3 films on GaAs*. (in press, Materials Horizons)

[2]. **Chen, R.**[*], Tang, A., Dutta, J., Tara, V., Ye, J., Fang, Z., Majumdar, A.[*] (2025). *NEO-PGA: Nonvolatile electro-optically programmable gate array*. (submitted, Nature Photonics)

[3]. Audhkhasi, R., Tara, V., Klein, M., Tang, A., **Chen, R.**, Vangala, S., Hendrickson, J., Majumdar, A. (2025). *Electrically reconfigurable nonvolatile flatband absorbers in the mid-infrared with wide spectral tuning range*. (submitted, Nano Letters)

[4]. Dutta, J., Ferraro, A., Manna, A., **Chen, R.**, Pane, A., Lio, G.E., Caputo, R. and Majumdar, A. (2025). *Near-visible low power tuning of nematic-liquid crystal integrated silicon nitride ring resonator*. (under review, ACS Photonics)

[5]. Fang, J., Kala, A., Johnson, R., Sharp, D., **Chen, R.**, Chang, C., Munley, C., Froech, J.E., Varnakavi, N., Tang, A. and Manna, A. (2025). *Free Space Few-Photon Nonlinearity in Critically Coupled Polaritonic Metasurfaces*. (under review, Nature Communications)

[6]. Adya, U., **Chen, R.**, Chen, I., Joshi, S., Majumdar, A., Li, M., & Moazeni, S. (2024). *Non-volatile Tuning of Cryogenic Optical Resonators*. (under review, Nature Communications)

Journal publication

First authored

[1]. Fang, J.[†,*], **Chen, R.**[†], Sharp, D.[†], Renzi, E. M., Manna, A., Kala, A., ... & Majumdar, A. (2024). *Fang, J., Chen, R., Sharp, D., Renzi, E. M., Manna, A., Kala, A., ... & Majumdar, A.[*] (2024). Million-Q Free Space Meta-Optical Resonator at Visible Wavelengths.* Nature Communications, 15(1), 10341.

[2]. Fang, Z.[†,*], **Chen, R.**[†,*], Fröch, J. E., Tanguy, Q. A., Khan, A. I., Wu, X., ... & Majumdar, A.[*] (2024). *Nonvolatile Phase-Only Transmissive Spatial Light Modulator with Electrical Addressability of Individual Pixels.* ACS Nano, 18(17), 11245-11256.

[3]. **Chen, R.**[*], Tara, V., Dutta, J., Fang, Z., Zheng, J. and Majumdar, A.[*] (2024). *Low-loss multi-level operation using lossy PCM-integrated silicon photonics*. SPIE Journal of Optical Microsystems, 4(3), 031202.

[4]. **Chen, R.**[†,*], Tara, V.[†], Choi, M., Dutta, J., Sim, J., Ye, J., ... & Majumdar, A.[*] (2024). *Deterministic quasi-continuous tuning of phase-change material integrated on a high-volume 300-mm silicon photonics platform.* npj Nanophotonics, 1(1), 7.

[5]. **Chen, R.**, Tara, V., Singh, A. W., Saxena, A., Fröch, J. E., Reynolds, M. S., & Majumdar, A.[*] (2023). *A hybrid solution for spatial light modulators with a large space-bandwidth product: opinion*. Optical Materials Express, 13(8), 2416-2421.

[6]. **Chen, R.**[*], Fang, Z., Perez, C., Miller, F., Kumari, K., Saxena, A., ... & Majumdar, A.[*] (2023). *Non-volatile electrically programmable integrated photonics with a 5-bit operation*. Nature Communications, 14(1), 3465.

[7]. **Chen, R.**, Fang, Z., Miller, F., Rarick, H., Froch, J. E., & Majumdar, A.* (2022). *Opportunities and challenges for large-scale phase-change material integrated electro-photonics*. ACS Photonics, 9(10), 3181-3195.

[8]. **Chen, R.**, Fang, Z., Fröch, J. E., Xu, P., Zheng, J.*, & Majumdar, A.* (2022). *Broadband Nonvolatile Electrically Controlled Programmable Units in Silicon Photonics*. ACS Photonics, 9(6), 2142-2150.

Others

[9]. Dutta, J., Chen, R., Tara, V., Majumdar, A. (2025). *Low-power quasi-continuous hybrid volatile/nonvolatile tuning of ring resonators*. APL Photonics, 10(2), 020803.

[10]. Tara, V., **Chen, R.**, Fröch, J., Fang, Z., Fang, J., Audhkhasi, R., Choi, M. and Majumdar, A.* (2024). *Non-volatile reconfigurable transmissive notch filter using wide bandgap phase change material antimony sulfide*. IEEE Journal of Selected Topics in Quantum Electronics, 30(4), 4700108.

[11]. Adya, U., Sturm, D., **Chen, R.**, Wu, C., Majumdar, A., Li, M., and Moazeni, S. (2024). *Post-processing of phase change material in a zero-change commercial silicon photonic process*. Optics Express, 32(16), 27552-27562.

[12]. Sharp, D., Flower, C., Mehrabad, M.J., Manna, A., Rarick, H., **Chen, R.**, Hafezi, M. and Majumdar, A.* (2024). *Near-Visible Topological Edge States in a Silicon Nitride Platform*. Optical Materials Express, 14(6), 1596-1602.

[13]. Miller, F., **Chen, R.**, Fröch, J., Fang, Z., Tara, V., Geiger, S. and Majumdar, A.* (2024). *Rewritable photonic integrated circuit canvas based on low-loss phase change material and nanosecond pulsed lasers*. Nano Letters, 24(23), 6844−6849.

[14]. Fang, Z., **Chen, R.**, Zheng, J., & Majumdar, A.* (2021). *Non-Volatile Reconfigurable Silicon Photonics Based on Phase-Change Materials.* IEEE Journal of Selected Topics in Quantum Electronics, 28(3), 8200317.

[15]. Fang, Z.*, **Chen, R.**, Ryou, A., & Majumdar, A.* (2021). *1D self-healing beams in integrated silicon photonics.* ACS Photonics, 8(7), 2139-2147.

[16]. Fang, Z.*, **Chen, R.**, ..., Majumdar, A.* et al (2022). *Ultra-low energy programmable nonvolatile silicon photonics based on phase change materials with graphene heaters.* Nature Nanotechnology, 17(8), 842-848.

[17]. Fang, Z., **Chen, R.**, Tara, V., & Majumdar, A.* (2023). *Non-volatile phase-change materials for programmable photonics.* Science Bulletin, 68(8), 783-786.

[18]. Miller, F., **Chen, R.**, Fröch, J. E., Rarick, H., Geiger, S., & Majumdar, A.* (2023). *Rewritable photonic integrated circuits using dielectric-assisted phase-change material waveguides*. Optics Letters, 48(9), 2385-2388.

[19]. Prabhathan, P., Sreekanth, K. V., Teng, J., Ko, J. H., Yoo, Y. J., Jeong, H. H., ... & Singh, R. (2023). *Roadmap for phase change materials in photonics and beyond.* Iscience, 26(10), 107946.

[20]. Fang, Z., **Chen, R.**, Tossoun, B., Cheung, S., Liang, D., & Majumdar, A.* (2023). *Non-volatile materials for programmable photonics.* APL Materials, 11(10), 100603.

[21]. Fang, Z.†,*, Mills, B.†, **Chen, R.**, Zhang, J., Xu, P., Hu, J., & Majumdar, A.* (2023). *Arbitrary Programming of Racetrack Resonators Using Low-Loss Phase-Change Material Sb_2Se_3.* Nano Letters 24(1), 97-103.

[22]. Choi, M., Munley, C., Froech, J. E., **Chen, R.**, & Majumdar, A. (2023). *Nonlocal, Flat Band Meta-optics for Monolithic, High Efficiency, Compact Photodetectors.* Nano Letters 24(10), 3150-3156.

Conference publication

[1]. **Chen, R.**, Fang, Z., Zheng, J., Froech, J. & Majumdar, A. (2022, May). Nonvolatile electrically controllable broadband switches based on phase-change material GST. In *CLEO: Science and Innovations* (pp. SF2N-1). Optica Publishing Group.

[2]. **Chen, R.**, Fang, Z., Zheng, J., & Majumdar, A. (2022, October). Quasi-continuously tunable non-volatile photonic switches. In Active Photonic Platforms 2022 (Vol. 12196, pp. 38-46). SPIE.

[3]. **Chen, R.**, Fang, Z., Miller, F., Kumari, K., Saxena, A., & Majumdar, A. (2022, October). Electrically programmable wide bandgap phase-change material Sb_2S_3 enabling multi-level non-volatile photonics. In Frontiers in Optics (pp. FTu6C-1). Optica Publishing Group.

[4]. Yang, H., Cheng, Q., **Chen, R.**, & Bergman, K. (2020, March). Polarization-diversity microring-based optical switch fabric in a switch-and-select architecture. In 2020 Optical Fiber Communications Conference and Exhibition (OFC) (pp. 1-3). IEEE.

[5]. Fang, Z., **Chen, R.**, Ryou, A., & Majumdar, A. (2021, May). Observation of 1D self-healing Airy beams on a silicon photonic chip. In *CLEO: Science and Innovations* (pp. SW3C-7). Optica Publishing Group.

[6]. Fang, Z., **Chen, R.**, Zhang, J., Xu, P., & Majumdar, A. (2022, May). Low-loss broadband nonvolatile 2× 2 switch based on Sb2Se3 for programmable silicon photonics. In CLEO: Science and Innovations (pp. STh4G-6). Optica Publishing Group.

[7]. Fang, Z., **Chen, R.**, Zheng, J., Khan, A. I., Neilson, K. M., Saxena, A., ... & Majumdar, A. (2022, May). Ultra-low energy programmable non-volatile silicon photonics based on graphene heaters. In 2022 Conference on Lasers and Electro-Optics (CLEO) (pp. 1-2). IEEE.

[8]. Neilson, K., Tie, M., Ko, J. S., Jaikissoon, M., Yang, J., **Chen, R.**, ... & Pop, E. (2023, March). Lithographic Damage to Two Dimensional Materials Probed by Photoluminescence and Raman Spectroscopy. Bulletin of the American Physical Society.

[9]. Fang, Z., **Chen, R.**, Fröch, J. E., Tanguy, Q., Khan, A. I., Wu, X., ... & Majumdar, A. (2023, May). Non-volatile reconfigurable metasurface for free-space phase-only modulation. In CLEO: Science and Innovations (pp. SM2G-5). Optica Publishing Group.

[10]. Miller, F., **Chen, R.**, Fröch, J., Rarick, H., Geiger, S., & Majumdar, A. (2023, May). Rewritable Photonic Integrated Circuit with Phase Change Materials. In CLEO: Applications and Technology (pp. JW2A-11). Optica Publishing Group.

[11]. Majumdar, A., Fang, Z., & **Chen, R.** (2023, September). NEO-PGA: Nonvolatile Electro-Optically Programmable Gate Array. In 2023 28th Micro optics Conference (MOC) (pp. 1-2). IEEE.

[12]. Fang, Z., **Chen, R.**, Fröch, J. E., Tanguy, Q. A., Khan, A. I., Wu, X., ... & Majumdar, A. (2023, October). Nonvolatile transmissive metasurface with phase-only modulation. In Laser Science (pp. LTh3F-3). Optica Publishing Group.