Meiqi Yang (She/her/hers)

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RESEARCH INTERESTS

My research lies in designing advanced materials to improve the efficiency and reduce the cost for resource recovery from wastewater through data-driven modeling and advanced machine learning techniques.

EDUCATION

Princeton University   Princeton, NJ, USA
  Ph.D., Environmental Engineering   2020 - 2025 (expected)
  Thesis topic: Enhancing Resource Recovery from Wastewater via Data-driven Material Engineering
  Supervisor: Dr. Zhiyong Ren
  Supervisory committee members: Drs. Catherine A. Peters, Claire E White, Ryan S. Kingsbury, Liangbing Hu

Yale University   New Haven, CT, USA
  M.S., Environmental Engineering   2018 - 2019
  Research Supervisor: Drs. Menachem Elimelech and Shu Hu

Shandong University   Shandong, China
  B.S., Environmental Science   2014 - 2018

EMPLOYMENT

Research Assistant, Energy Institute II, Yale University   New Haven, CT, USA
  Projects: Atomic Layer Deposition for Multifunctional Coatings and Ion Selective Membranes   2019 - 2020
  Supervisor: Drs. Menachem Elimelech and Shu Hu

AWARDS & HONORS

2024	Graduate Conferences Fellowship, Andlinger Center for Energy and the Environment
2023	Graduate Conferences Fellowship, Andlinger Center for Energy and the Environment
2020 - 2021	The Thomas J. Nelson *68 and Mary Baker Nelson SEAS Fellowship
May 2017	National Innovation and Entrepreneurship Training Program, Ministry of Education of the People's Republic of China. (Group Leader)
2015 - 2016	Shandong University Scholarship and Merits Student, Shandong University

RESEARCH EXPERIENCE & PROJECTS

April. 2022 - Present   Selective Li Extraction via Cellulose Material Engineering and Surface Treatment

- Design an efficient and self-concentrating crystallization method for the selective extraction of lithium from both brines and seawater;
- Synthesize novel 3D cellulose crystallizers with tunable porosity and surface properties, which achieves a state-of-the-art evaporation rate as high as 9.8 kg m^{-2} h^{-1};
- Achieve Li selectivity among other co-exist ions by orders of magnitude;
- Uncover the mechanism of crystallization from both theory and simulation.

Aug. 2021 - Present	Machine learning (ML)-assisted Pervaporation (PV) Membrane Design for Organic Recovery

- Develop predictive ensemble models to select promising polymers from 1 million candidates for organic extraction, which overcomes the limitations of speed and cost of the traditional experimental approaches;
- Construct a state-of-the-art PV dataset with ~3000 data points from 283 literatures;
- Improve ML models' robustness via data leakage management;
- Incorporate explainable ML-techniques to understand the separation mechanism of the selected membranes, assisting experimental design with data-driven evidence.

Jan. 2024 - Present	Industry-level Model Development for Lithium Extraction

- Translating research project published at Nature Water (see Journal Publication [1]) to industry-level lithium extraction;
- Develop evaporation model and climate model that could facilitate the industrial lithium production;
- Improve the accuracy of evaporation model that help reduce error from 52.46% to 6.01%, significantly helps real operation and reduce cost;
- Establish climate model with improved accuracy, which reduced 30% error.

June 2023 - Present	Advancing Environmental Studies with a Specialized Large Language Model (LLM)

- Develop the largest textbook-based Q&A dataset to date, comprising over 2,000 Q&A examples from 22 environmental textbooks, enhancing resource availability in the environmental domain;
- Perform large-scale data analysis for knowledge synthesis from the textbook datasets;
- Create an open-source LLM platform, specifically enriched with environmental knowledge, to support research and education in environmental studies.

Aug. 2020 - June 2021	Multielement Alloy Catalysts Design for Selective Electrocatalytic Nitrate Reduction (ENR) to Ammonia

- The first study that investigates the synergistic effect between multiple reaction sites on multi-elemental alloy nanoparticles for effective ENR reaction;
- Optimize the operational parameters such as electrolyte conditions and applied potentials to achieve a high NH_3 faradaic efficiency (93.5%) in industrially relevant acidic wastewater;
- Develop a continuous flow reactor with doubled ammonia yield (3171.0 μg h^{-1} cm^{-2}) compared with pure Ru catalyst.

PARTICIPATION IN PROPOSAL WRITING

- Department of Energy (DOE), reference number: DE-FOA-0003105, Opportunity: Critical Material Innovation, Efficiency, and Alternatives

JOURNAL PUBLICATIONS (†first author with equal contribution)

• **Cellulose-based Material Design for Mineral Recovery and Desalination**

1. **Meiqi Yang†**, Chen, Xi†, Sunxiang Zheng, Fernando Temprano-Coleto, Qi Dong, Guangming Cheng, Nan Yao, Howard A. Stone, Liangbing Hu, and Zhiyong Jason Ren. "Spatially Separated Crystallization for Selective Lithium Extraction from Saline Water." *Nature Water* (2023). (*Front Cover, Princeton News Release*)

2. Sunxiang Zheng, **Meiqi Yang**, Xi Chen, Claire E. White, Liangbing Hu, and Zhiyong Jason Ren. "Upscaling 3D Engineered Trees for Off-Grid Desalination." *Environmental science & technology* (2022). (**Top journal in environmental study field**)

- **Machine Learning-assisted Membrane Design for Organic Recovery**

3. **Meiqi Yang,** Jun-Jie Zhu, Allyson McGaughey, Rodney D. Priestley, Eric M. V. Hoek, David Jassby, Zhiyong Jason Ren "Machine Learning for Polymer Design to Enhance Pervaporation-Based Organic Recovery." *Environmental science & technology*, 2024 **(Top journal in environmental study field, front cover)**

4. **Meiqi Yang**, Jun-Jie Zhu, Allyson McGaughey, Sunxiang Zheng, Rodney D. Priestley, and Zhiyong Jason Ren. "Predicting Extraction Selectivity of Acetic Acid in Pervaporation by Machine Learning Models with Data Leakage Management." *Environmental Science & Technology* 57, no. 14 (2023): 5934-5946. **(Top journal in environmental study field)**

5. Jun-Jie Zhu, **Meiqi Yang**, and Zhiyong Jason Ren. "Machine Learning in Environmental Research: Common Pitfalls and Best Practices." *Environmental Science & Technology* (2023). *(Supplementary Cover)*

6. Jun-Jie Zhu, Jinyue Jiang, **Meiqi Yang**, and Zhiyong Jason Ren. "ChatGPT and environmental research." *Environmental Science & Technology* (2023). *(Most downloaded paper)*

- **Material Engineering for Wastewater Treatment, Decarbonization, and Sustainability**

7. **Meiqi Yang**, Boyang Li, Shuke Li, Qi Dong, Zhennan Huang, Sunxiang Zheng, Ying Fang et al. "Highly Selective Electrochemical Nitrate to Ammonia Conversion by Dispersed Ru in a Multielement Alloy Catalyst." *Nano Letters* (2023). *(Supplementary Cover)*

8. **Meiqi Yang†**, Xin Shen†, Chengxing He, Tianshuo Zhao, Devan Solanki, Rito Yanagi, Ben Gibbs, Gouri Krishnan, and Shu Hu. "Multicolor Bipolar Modulation of Titanium–Chromium Oxide Electrochromic Coatings." *ACS Applied Electronic Materials* 5, no. 3 (2023): 1812-1823.

9. Xiaobo Zhu, Joshua Jack, Aaron Leininger, **Meiqi Yang**, Yanhong Bian, Jonathan Lo, Wei Xiong, Nicolas Tsesmetzis, and Zhiyong Jason Ren. "Syngas mediated microbial electrosynthesis for CO2 to acetate conversion using Clostridium ljungdahlii." Resources, Conservation and Recycling 184 (2022): 106395.

10. Xin Shen, Tianshuo Zhao, Haoqing Su, **Meiqi Yang**, Jiaye Chen, Yulin Liu, Rito Yanagi, Devan Solanki, and Shu Hu. "Tuning Intermediate Bands of Protective Coatings to Reach the Bulk−Recombination Limit of Stable Water−Oxidation GaP Photoanodes." *Advanced Energy Materials* 12, no. 29 (2022): 2201314.

11. Tianshuo Zhao, Rito Yanagi, Yijie Xu, Yulian He, Yuqi Song, **Meiqi Yang**, and Shu Hu. "A coating strategy to achieve effective local charge separation for photocatalytic coevolution." *Proceedings of the National Academy of Sciences* 118, no. 7 (2021): e2023552118.

12. Xuechen Zhou, Mohammad Heiranian, **Meiqi Yang**, Razi Epsztein, Kai Gong, Claire E. White, Shu Hu, Jae-Hong Kim, and Menachem Elimelech. "Selective Fluoride Transport in Subnanometer TiO2 Pores." *ACS nano* 15, no. 10 (2021): 16828-16838.

13. **Meiqi Yang**, Xuefei Sun, Shuguang Wang, *Preparation of carboxymethyl chitosan-glucan composite microspheres and adsorption behavior to fluorine ion,* [J]. Acta Scientiae Circumstantiae, 2017, 37(12): 1-7.

PREPRINTS

1. **Meiqi Yang**, Kaijie Yang, Hongxu Chen, Sunxiang Zheng, Zhiyong Jason Ren "Developing Novel Evaporation-based Extraction Process for Lithium Recovery from Oil and Shale Gas Brine." Energy & Environmental Science.

2. Jun-Jie Zhu, **Meiqi Yang**, Jinyue Jiang and Zhiyong Jason Ren. "Cost-Accuracy Evaluation of Large Language Models for Domain-Specific Question-Answering." ES&T Letters.

UNDER PREPARATION

1. **Meiqi Yang**, Kaijie Yang, Hongxu Chen, Sunxiang Zheng, Zhiyong Jason Ren "Lithium Extraction from Brines by Selective Crystallization with Surface Functionalization."

2. Kaijie Yang, **Meiqi Yang**, Hongxu Chen, Sunxiang Zheng, Zhiyong Jason Ren "Leveraging Solar Energy to Revolutionize Brine Mining."

CONFERENCE & PRESENTATION

- Towards an environmentally just transition: the future of lithium mining, *Princeton Energy & Climate Scholars (PECS) & Princeton High Meadows Environmental Institute (HMEI)*, 2024, invited panelist

- New material for selective and effective lithium extraction from saline water, *American Chemical Society*, New Orlean, 18 March, 2024, poster presentation

- Machine learning for polymer design to enhance pervaporation-based organic recovery, *American Chemical Society*, New Orlean, 19 March, 2024, oral presentation

- Leveraging Wood Chemistry for High-Performance Selenium Recovery with Reactive Evaporator, *Association of Environmental Engineering and Science Professors*, Boston, 20 June, 2023, oral presentation

- Spatially Separated Crystallization for Selective Lithium Extraction from Saline Water, *Materials Imaging Workshop*, 3 November, 2023, invited oral presentation

- Enhancing Pervaporation-based Organic Recovery through Machine Learning-Assisted Polymer Design, *Association of Environmental Engineering and Science Professors*, Boston, 20 June, 2023, poster presentation

- Accelerated Lithium Extraction from Brines with Interfacial Evaporation, *American Geophysical Union Conference*, Chicago, 12 December, 2022, poster presentation

- Highly Selective Electrochemical Nitrate to Ammonia Conversion in Acidic Industrial Wastewater Condition by Dispersed Ru in a Multielement Alloy Catalyst, *Andlinger Center for Energy and the Environment Annual Meeting*, Princeton, 14 October, 2022, poster presentation

- Preparation of carboxymethyl Chitosan Microspheres and the Adsorption of Heavy Metal Cadmium, *International Conference on Innovative Material Science and Technology*, IMST 2016, 305-313.

PATENTS

- **Meiqi Yang**, *a Fluorine-Containing Wastewater Treatment Plant*. **Certificate of Utility Model Patent: ZL 201720239707.7**

TEACHING & MENTORSHIP

- Linda Zeng, The Harker Upper School, California, High School Student, June - July 2024

- Christopher Li, Princeton University, Sophomore, Feb. - May 2024

- Ryan Neapole, Princeton University, Undergrad Thesis, now at Stanford University, Feb. - May 2023

- Qixiang Feng, Princeton International School of Mathematics and Science, High School Student, June - Aug. 2023

- Siyu (Quinn) Li, Dwight-Englewood School, High School Student, now at University of Pennsylvania, 2022

- ENE321-CEE321_F2021 Resource Recovery for a Circular Economy, Teaching Assistant, 2021 Fall

- Gouri Krishnan, King School in Stamford, High School Student, now at Columbia University, 2019

SKILLS

- **Software**: Pytorch, Python, UNIQUAC, COMSOL, FDTD, Avizo, Athena, Artemis, AutoCAD

- **Instrumental Operation**: X-ray photoelectron spectroscopy (XPS), X-ray powder diffraction (XRD), Scanning/Transmission Electron Microscope (S/TEM), Atomic Layer Deposition (ALD), Scanning electron microscope (SEM), UV-Vis-DRS, Ellipsometry, Electrochemical Impedance Spectroscopy (EIS), and 3D X-ray tomography Microscope, etc.