

## Keyu Wang

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### EDUCATION

**Duke University**  
MS in Materials Science and Engineering; GPA:3.71/4.0  
**Nankai University**  
BS in Physics; GPA:3.67/4.0

Advisor: Po-Chun Hsu  
2020-2022  
Advisor: Chenghou Tu  
2016-2020

### SKILLS

- **Characterization:** Scanning Electron Microscope (SEM)&ImageJ, X-ray diffraction (XRD)&Jade, Raman Atomic Force Microscope system (Raman-AFM), MicroCT, Fourier-transform infrared spectroscopy (FTIR), UV-Vis-NIR Spectroscopy with Integrating Sphere
- **Lab/Fab:** Cold Isostatic pressing (CIP), Evaporation, Spin-coating, Lithography, Wet etching, Reactive ion etching, Battery tester, EC-lab, 3D Printer, Polishing
- **Programming:** C++/C, MATLAB (ANOVA, Scale-Invariant Feature Transform /SIFT, etc.), Python (Bayesian Optimization, Gaussian Process Regression, Langevin Sampling, etc.), LabView
- **Simulation:** COMSOL Multiphysics (Acoustics, Wave Optics, Battery), EnergyPlus, AFLOW
- **Graphics:** 3ds Max, Origin, ChemDraw

### RESEARCH INTERESTS

Micro- and nanometer scales energy transport and conversion; Carrier transport and interaction; Thermal radiation; Phase change heat transfer

### RESEARCH EXPERIENCES

- **MS research with Prof. Po-Chun Hsu; Duke University & The University of Chicago** **2020-present**
  - ◆ **Enhance CO<sub>2</sub> release in ethanolamine (MEA) by Photomolecular effect**
    - Verified [photomolecular effect](#) at the liquid-vapor interface of water by building up the weight measurement platform of water evaporation under the high-power visible lamp, which explained the water evaporation rate exceeding the thermal limit.
    - Studied dependence of the photomolecular evaporation rate on the wavelength, the angle of incidence, humidity, and temperature.
    - Learned the distribution of gradient electric field based on macroscopic Maxwell equation (Tangential electric field boundary conditions) and the force acting on the dipole of water molecular and [quadrupole of water cluster](#).
    - Set up vapor phase temperature distribution measurement platform to verify the breaking off and [recondensation](#) of water cluster, which explained the weight recovery of water as the light off.
    - Studied the [CO<sub>2</sub> capture and release](#) reaction in MEA by analyzing the free-energy barrier between intermediate products to design the CO<sub>2</sub> photomolecular releasing experiment and verify the [ubiquity of photomolecular effect](#).
    - Calculated the [charge separation](#) of CO<sub>2</sub> molecular and negative ion of carboxylate and bond energy of intermediate product to study momentum conservation and energy conservation, respectively.
  - ◆ **Bio-Inspired Design of Vascularized Electrodes for High-Performance Fast-Charging Batteries**
    - Designed the cathode structure of fast-charging lithium-ion battery for high capacity with [COMSOL Multiphysics](#) and analyzed the dependence of battery capacity on [tortuosity](#) and [gradual porosity](#) of battery electrodes which is verified by porous electrode theory.
    - Fabricated the vertical channel templates in the cathode by [spin-coating](#) or [evaporation](#) onto silicon substrate: PMMA, Nylon 6, nickel (Ni), Nylon 6, S1813 (negative photoresist), and gold (Au). Created open trenches with [photolithography](#) of negative photoresist. Au acts as a protective hard mask to allow oxygen plasma-induced [dry etching](#) of nylon layers as well as iron (III) chloride [wet etching](#) of Ni.
    - Created gradual porosity in cathode by [differential sediment](#) of LCO slurry based on Stokes's Law. Assembled coin cell with metal lithium anode and LCO cathode with gradual porosity and vertical channels in the [glove box](#). Measured coin cell capacity through galvanostatic discharge tests on [EC-Lab](#) software.

- ◆ **Low-haze high visible transparent low emissivity window for building energy saving**
  - Designed geometrical density of silver nanowires (AgNWs) for visible transparent and low mid-IR emissivity window based on the cutoff frequency of [wire mesh screen model](#).
  - Spin-coated AgNWs onto glass to fabricate the low-E window and characterized the performance of the window with [FTIR](#) and [UV-Vis-NIR Spectroscopy with Integrating Sphere](#).
  - Characterized the [haze](#) of the window with different diameters of AgNWs based on scattering theory.
- **BS research assistant with Prof. Zheng Li; Virginia Tech** **2019-2020**
  - ◆ **Interface optimization of aqueous sodium-sulfur batteries**
    - Coated hydrophobic layer onto beta-aluminum ceramics separator to obtain effective solid electrolyte separator which has phase stability toward aqueous solution around room temperature and characterized ceramics separator with SEM and XRD.
    - Fabricated [aqueous sodium-sulfur battery](#) based on  $\text{Na}_2\text{S}_4/\text{Na}_2\text{S}_2$  redox couple, which showed a noticeable capacity and stability from [battery tester](#) and designed [in situ Raman](#) device to analyze polysulfide conversion reactions in the aqueous system.
    - Prepared for  $\text{Na}_3\text{Zr}_2\text{Si}_2\text{PO}_{12}$  (NASICON) ceramics separator as a comparison to verify the stability of hydrophobic layer coated beta-aluminum separator.
- **BS research with Prof. Chenghou Tu (Nankai University)** **2018-2020**
  - ◆ Principles and Applications of Dielectric Metasurfaces with Phase Modulation
- **BS research with Prof. Xiubin Yang (Changchun Institute of Optics, Fine Mechanics, and Physics, Chinese Academy of Sciences)**
  - ◆ Estimation of Image Quality Based on Statistical Region Merge

## PUBLICATION

[1] Sui, C., Li, Y. Y., Li, X., Higueros, G., **Wang, K.**, Xie, W., & Hsu, P. C. (2022). Bio-Inspired Computational Design of Vascularized Electrodes for High-Performance Fast-Charging Batteries Optimized by Deep Learning. *Advanced Energy Materials*, 12(6), 2103044.

## HONORS

- First-Class Scholarship (3/176), Nankai University 2016-2017
- Volunteer Scholarship (1/174), Nankai University 2017-2018
- Leadership Scholarship (1/174), Nankai University 2017-2018
- First Prize of the Physics Contest, Nankai University May.2017
- Taiwan College-Student Physicists' Tournament Jan. 2018

## TEACHER ASSISTANT AND LEADERSHIP

- **Teacher Assistant: Fundamental of Computer for Science and Engineering, Nankai University**
  - ◆ Organized workshops weekly to help 200 students in C++ programming
- **President of Volunteer Association of The School of Physics, Nankai University**
  - ◆ Organized Science Popularizing activities and compulsory work for autistic children
- **Assistant Minister of Administration Section in Nankai Volunteer Association**
  - ◆ Organized volunteers from Nankai University for National Games of the People's Republic of China
- **President in school of physics for class of 2020**