

## Jingshan S. Du

Mailing Address: Cook Hall 2032, 2220 Campus Drive, Evanston, IL 60208

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Email: [du@u.northwestern.edu](mailto:du@u.northwestern.edu)Website: <http://dujingshan.tk/>ORCID:  0000-0002-4932-6699**EDUCATION****Northwestern University**

Evanston, IL

Ph.D., Materials Science and Engineering

*expected August 2021*

Thesis: Complex Nanoparticle Systems: Structures, Structure–Function Relationships, and Dynamics

Supervised by Prof. Chad A. Mirkin and Prof. Vinayak P. Dravid

**Zhejiang University Chu Kochen Honors College**

Hangzhou, China

B.Sc. (Hons), Engineering: Materials Science and Engineering

June 2015

Thesis: Direct Observation of AgCl–Ag Transformation Dynamics Using In-situ Transmission Electron Microscopy

Supervised by Prof. Deren Yang and Prof. David A. Weitz

**RESEARCH EXPERIENCE****Northwestern University**

Evanston, IL

Research Assistant, International Institute for Nanotechnology

2015–present

Faculty Advisors: Prof. Chad A. Mirkin and Prof. Vinayak P. Dravid

Ryan Fellow (2017–2020); Fellow, Hierarchical Materials Cluster Program (2016–2017)

DPN Subgroup Leader (2019–present)

Topics: nanoparticles as complex systems; nanoscale phase transformation; correlated and in-situ electron microscopy; combinatorial synthesis and characterization

**Harvard University**

Cambridge, MA

Visiting Undergraduate, School of Engineering and Applied Sciences

2014–2015

Faculty Advisor: Prof. David A. Weitz

Topics: nanoscale interfacial reactions; in-situ electron microscopy; graphene liquid cells

**University of California, Los Angeles**

Los Angeles, CA

Visiting Undergraduate, California NanoSystems Institute

Summer 2014

Faculty Advisor: Prof. Xiangfeng Duan

Fellow, Cross-disciplinary Scholars in Science and Technology (CSST) Program

Topics: mixed oxide electrocatalysts for oxygen evolution reaction

**Zhejiang University**

Hangzhou, China

Undergraduate Research Assistant, State Key Laboratory of Silicon Materials

2013–2015

Faculty Advisors: Prof. Deren Yang and Prof. Hui Zhang

Ministry of Education of China National University Student Innovation Program Grant (2013–2014)

Topics: thermal-resistant metal/oxide hybrid nanostructures; shaped-controlled synthesis of noble metal nanocrystals

**TEACHING AND MENTORING****Northwestern University**

Evanston, IL

Teaching Assistant, MAT\_SCI 301 Materials Science Principles (with Labs)

Fall 2017

Teaching Assistant, MAT\_SCI 466 Analytical Electron Microscopy (with Labs)

Spring 2018

Mentored graduate research:

Carolyn B. Wahl, PhD Student. Materials Science and Engineering

2019–present

Topics: complex metal alloy nanoparticles

## Curriculum Vitae

David D. Xu, PhD Student, Chemistry

Jingshan S. Du

2019–present

Topics: upconverting nanoparticle arrays and libraries

Mingue Shin, Visiting PhD Student, Materials Science and Engineering

2019–2020

Topics: halide perovskite nano-LEDs

Qian Rong, Visiting PhD Student, Materials Science and Engineering

2019

Topics: hierarchically porous multicomponent oxide electrocatalysts for oxygen evolution

Donghoon Shin, PhD Student, Materials Science and Engineering

2018–2021

Topics: patterning and optoelectronics of halide perovskite nanocrystals

Mentored undergraduate research:

Benjamin Kaiser, REU (MRSEC)

Summer 2018

Topics: graphene-liquid interaction

Juan Diego Martin, REU (NNCI/SHyNE)

Summer 2017

Topics: graphene-encapsulated imaging of microbes

Kevin Qiu, REU (MRSEC) and Undergraduate Research Assistant

2016–2018

Topics: graphene-liquid interaction; graphene-encapsulated imaging of soft materials

## SERVICE AND PROFESSIONAL EXPERIENCE

### SPIE Northwestern University Chapter

Evanston, IL

President

2019–2020

Vice President

2018–2019

Coordinator, SPIE-MRSEC Student Seminar Series

2017–2018

### Kuang-Chi Institute of Advanced Technology

Shenzhen, China

Assistant Engineer/Intern, Development Center

Summer 2013

Topics: design and fabrication of composite metamaterials

## CONFERENCE ORGANIZATION

Conference Chair, *SPIE FOCUS: Light and Matter*, October 12<sup>th</sup>–13<sup>th</sup>, 2019. Evanston, IL

## SIGNIFICANT RECOGNITIONS

MRS Graduate Student Silver Award, Materials Research Society

2021

IIN Outstanding Research Award, International Institute for Nanotechnology, Northwestern University

2020

SPIE Optics and Photonics Education Scholarship, SPIE

2020

Perkin Scholarship, Society of Chemical Industry America

2019

IPMI Sabin Metal Ron Bleggi Award, International Precious Metals Institute

2019

Park AFM Scholarship, Park Systems Inc.

2018

Top 100 Bachelor's Thesis Award, Zhejiang University

2015

Chu Kochen Scholarship (Presidential Award), Zhejiang University

2014

Chu Kochen Honors College Scholarship for Excellence (Dean's Award), Zhejiang University

2014

National Scholarship (Undergraduate), Ministry of Education of China

2014

Cross-disciplinary Scholars in Science and Technology (CSST) Award, University of California, Los Angeles

2014

Kwanjeong Educational Foundation Scholarship, Kwanjeong Educational Foundation and Zhejiang University

2012, '13, '14

Chou Pei-yuan Award for Youths in Science and Technology Innovation, Chou Pei-yuan Foundation

2010

**MEDIA HIGHLIGHTS AND VOICES**

Primarily featured by:

“Du awarded SPIE Optics and Photonics Education Scholarship” and “Scholarship awarded for study of nanoparticle structures and dynamics”

SPIE.org and International Institute for Nanotechnology News. May 2020

“Park AFM Scholarship Awards - JINGSHAN DU”

*NanoScientific* **2018**, 13, 23–24 and the Park AFM website. May 2018

“Asking Myself at the Finish Line of College”

Zhejiang University Homepage. April 2015

Voices and opinions appeared in:

“As DFT matures, will it become a push-button technology?” by Sam Lemonick

*Chemical & Engineering News* **2019**, 97 (35), 16–19. September 2019

**JOURNAL ARTICLES**

†Contributed Equally

- [1] Bidirectional Nanomodification Enables Hierarchically Structured Mixed Oxide Electrodes for Oxygen Evolution.  
Rong, Q.†; **Du, J. S.**†; Chen, X.; Liu, Q.; Dravid, V. P. (‡mentored student)  
*Small* **2021**, 17 (17), 2007287.  
► Highlighted by *Northwestern Engineering News*; also reprinted by *International Institute for Nanotechnology News*.
- [2] Twin Pathways: Discerning the Origins of Multiply Twinned Colloidal Nanoparticles.  
**Du, J. S.**; Zhou, W.; Ripich, S. M.; Mirkin, C. A.  
*Angewandte Chemie International Edition* **2021**, 60 (13), 6858–6863
- [3] Position- and Orientation-Controlled Growth of Wulff-Shaped Colloidal Crystals Engineered with DNA.  
Sun, L.; Lin, H.; Li, Y.; Zhou, W.; **Du, J. S.**; Mirkin, C. A.  
*Advanced Materials* **2020**, 32 (47), 2005316.
- [4] Halide Perovskite Nanocrystal Arrays: Multiplexed Synthesis and Size-dependent Emission.  
**Du, J. S.**†; Shin, D.†; Stanev, T. K.; Musumeci, C.; Xie, Z.; Huang, Z.; Lai, M.; Sun, L.; Zhou, W.; Stern, N. P.; Dravid, V. P.; Mirkin, C. A. (‡mentored student)  
*Science Advances* **2020**, 6 (39), eabc4959.  
► Highlighted by *Nature Electronics* **2020**, 3 (10), 582, *Perovskite-Info*, and *Northwestern Engineering News*; also reprinted by *International Institute for Nanotechnology News*.
- [5] Chain-End Functionalized Polymers for the Controlled Synthesis of Sub-2 nm Particles.  
Chen, P.-C.; Liu, Y.; **Du, J. S.**; Meckes, B.; Dravid, V. P.; Mirkin, C. A.  
*Journal of the American Chemical Society* **2020**, 142 (16), 7350–7355.
- [6] Light-Responsive Colloidal Crystals Engineered with DNA.  
Zhu, J.; Lin, H.; Kim, Y.; Yang, M.; Skakuj, K.; **Du, J. S.**; Lee, B.; Schatz, G. C.; Van Duyne, R. P.; Mirkin, C. A.  
*Advanced Materials* **2020**, 32 (8), 1906600.
- [7] Colloidal Crystal “Alloys.”  
Wang, S.; **Du, J. S.**; Diercks, N. J.; Zhou, W.; Roth, E. W.; Dravid, V. P.; Mirkin, C. A.  
*Journal of the American Chemical Society* **2019**, 141 (51), 20443–20450.
- [8] Particle Analogs of Electrons in Colloidal Crystals.  
Girard, M.†; Wang, S.†; **Du, J. S.**†; Das, A.†; Huang, Z.; Dravid, V. P.; Lee, B.; Mirkin, C. A. Olvera de la Cruz, M.  
*Science* **2019**, 364 (6446), 1174–1178.  
► Highlighted by *MRS Bulletin* **2019**, 44 (11), 837, *Quanta Magazine*, *The Economist Espresso*, *Northwestern Now*, and Argonne National Laboratory Press Release; also reprinted by *PHYS.ORG*, *Advanced Photon Source Science Highlights*, *Civil + Structural Engineer*, *Nanowerk News*, etc.

- [9] Interface and Heterostructure Design in Polyelemental Nanoparticles.  
Chen, P.-C.; Liu, M.; **Du, J. S.**; Meckes, B.; Wang, S.; Lin, H.; Dravid, V. P.; Wolverton, C.; Mirkin, C. A.  
*Science* **2019**, *363* (6430), 959–964.  
► Highlighted by *Nano Today* **2019**, *26*, 5-6 and *Northwestern Now*; also reprinted by *Materials Today News*, PHYS.ORG, ScienceDaily, Nanowerk News, etc.
- [10] Catalyst Discovery Through Megalibraries of Nanomaterials.  
Kluender, E. J.†; Hedrick, J. L.†; Brown, K. A.; Rao, R.; Meckes, B.; **Du, J. S.**; Moreau, L. M.; Maruyama, B.; Mirkin, C. A.  
*Proceedings of the National Academy of Sciences of the United States of America* **2019**, *116* (1), 40–45.  
► Highlighted by *Science News*, *Nature Review Chemistry* **2019**, *3* (2), 66, and *Northwestern Now*; also reprinted by PHYS.ORG, Nanowerk News, etc.
- [11] Windowless Observation of Evaporation-Induced Coarsening of Au-Pt Nanoparticles in Polymer Nanoreactors.  
**Du, J. S.**; Chen, P.-C.; Meckes, B.; Kluender, E. J.; Xie, Z.; Dravid, V. P.; Mirkin, C. A.  
*Journal of the American Chemical Society* **2018**, *140* (23), 7213–7221.  
► Highlighted by *International Institute for Nanotechnology News*.
- [12] Multi-Stage Transformation and Lattice Fluctuation at AgCl-Ag Interface.  
**Du, J. S.**; Park, J.; Kim, Q.; Jhe, W.; Dravid, V. P.; Yang, D.; Weitz, D. A.  
*Journal of Physical Chemistry Letters* **2017**, *8* (23), 5853–5860.
- [13] The Structural Evolution of Three-component Nanoparticles in Polymer Nanoreactors.  
Chen, P.-C.; **Du, J. S.**; Meckes, B.; Huang, L.; Xie, Z.; Hedrick, J. L.; Dravid, V. P.; Mirkin, C. A.  
*Journal of the American Chemical Society* **2017**, *139* (29), 9876–9884.
- [14] Solution-Phase Photochemical Nanopatterning Enabled by High-Refractive-Index Beam Pen Arrays.  
Xie, Z.†; Gordiichuk, P.†; Lin, Q.-Y.; Meckes, B.; Chen, P.-C.; Sun, L.; **Du, J. S.**; Zhu, J.; Liu, Y.; Dravid, V. P.; Mirkin, C. A.  
*ACS Nano* **2017**, *11* (8), 8231–8241.  
► Highlighted by *ACS Nano* **2017**, *11* (9), 8537–8541.
- [15] The Structural Fate of Individual Multicomponent Metal-Oxide Nanoparticles in Polymer Nanoreactors.  
**Du, J. S.**†; Chen, P.-C.†; Meckes, B.; Xie, Z.; Zhu, J.; Liu, Y.; Dravid, V. P.; Mirkin, C. A.  
*Angewandte Chemie International Edition* **2017**, *56* (26), 7625–7629.
- [16] Embedding Ultrafine Pt Nanoparticles at Ceria Surface for Enhanced Thermal Stability.  
**Du, J. S.**†; Bian, T.†; Yu, J.; Jiang, Y.; Wang, X.; Yan, Y.; Li, Y.; Jin, C.; Zhang, H.; Yang, D.  
*Advanced Science* **2017**, *4* (9), 1700056.
- [17] Intermetallic Nanocrystals: Syntheses and Catalytic Applications.  
Yan, Y.; **Du, J. S.**; Gilroy, K. D.; Yang, D.; Xia, Y.; Zhang, H.  
*Advanced Materials* **2017**, *29* (14), 1605997. (Invited Review)
- [18] Developing an Aqueous Approach for Synthesizing Au and M@Au (M = Pd, CuPt) Hybrid Nanostars with Plasmonic Properties.  
**Du, J.**; Yu, J.; Xiong, Y.; Lin, Z.; Zhang, H.; Yang, D.  
*Physical Chemistry Chemical Physics* **2015**, *17* (2), 1265–1272.
- [19] Kinetically-controlled Growth of Cubic and Octahedral Rh-Pd Alloy Oxygen Reduction Electrocatalysts with High Activity and Durability.  
Yan, Y.†; Zhan, F.†; **Du, J.**; Jiang, Y.; Jin, C.; Fu, M.; Zhang, H.; Yang, D.  
*Nanoscale* **2015**, *7* (1), 301–307.
- [20] Facile Synthesis of High-quality Pt Nanostructures with Controlled Aspect-ratio for Methanol Electro-oxidation.  
Li, Y.; Bian, T.; **Du, J.**; Xiong, Y.; Zhan, F.; Zhang, H.; Yang, D.  
*CrystEngComm* **2014**, *16* (36), 8340–8343.

[21] Langmuir Isotherm in Solution Adsorption Experiment.

**Du, J.**

*Research & Exploration in Laboratory* **2014**, *33* (10), 207–210.

[22] A Design of a Remote-Control Telescope System for High-School Students.

**Du, J.;** Liu, Y.; Fu, S.; Lin, L.

*Astronomical Research & Technology* **2013**, *10* (2), 194–200. **(Front Cover)**

#### INVITED TALKS

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[1] Halide Perovskite Nanocrystal Arrays: Multiplexed Synthesis and Size-Dependent Emission.

*SPIE Student Seminar Series*, August 4<sup>th</sup>, 2020. Online Virtual Meeting.

[2] Accelerating Complex Nanomaterial Discovery Using A Combinatorial Library Approach (Award Address).

*43<sup>rd</sup> International Precious Metals Institute Annual Conference*, June 15<sup>th</sup>–18<sup>th</sup>, 2019. Reno, NV.

[3] Classical Electron Equivalent Nanoparticles in Metal-like Colloidal Crystals.

*36<sup>th</sup> John E. Hilliard Symposium, Northwestern University*, May 16<sup>th</sup>, 2019. Evanston, IL.

#### CONTRIBUTED PRESENTATIONS

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[1] Elucidating the Plasmonic Modes in Metal Nanojunctions with Nanoparticle Libraries.

**Du, J. S.;** Cherqui, C.; Schatz, G. C.; Dravid, V. P.; Mirkin, C. A.

*2021 MRS Spring Meeting*. April 18<sup>th</sup>–23<sup>rd</sup>, 2021. Online Virtual Meeting. (Oral talk)

[2] Multiplexed Nanocrystal Arrays of Halide Perovskites.

**Du, J. S.;** Shin, D.; Dravid, V. P.; Mirkin, C. A.

*2021 MRS Spring Meeting*. April 18<sup>th</sup>–23<sup>rd</sup>, 2021. Online Virtual Meeting. (Oral talk)

[3] Microscopy-Based Approaches to Characterizing Analogs of Classical Electrons in Colloidal Crystals Engineered with DNA.

**Du, J. S.;** Wang, S.; Dravid, V. P.; Mirkin, C. A.

*Microscopy & Microanalysis 2020*. August 3<sup>rd</sup>–7<sup>th</sup>, 2020. Online Virtual Meeting. (Oral talk)

[4] Hierarchically Structured Mixed Oxide Electrodes for Oxygen Evolution Reaction: A Multimodal Electron Microscopy Study.

**Du, J. S.;** Rong, Q.; Chen, X.; Liu, Q.; Dravid, V. P.

*Microscopy & Microanalysis 2020*. August 3<sup>rd</sup>–7<sup>th</sup>, 2020. Online Virtual Meeting. (Oral talk)

[5] Polymer Nanoreactor Approach for Combinatorial Investigation of Complex Nanoparticles.

**Du, J. S.;** Dravid, V. P.; Mirkin, C. A.

*Gordon Research Conference & Seminar: Crystal Growth and Assembly*, June 22<sup>nd</sup>–28<sup>th</sup>, 2019. Manchester, NH. (Poster)

[6] Attoliter Polymer Reactors as Combinatorial Tools for Understanding Alloy Nanocrystal Structure–Function Relationship.

**Du, J. S.;** Dravid, V. P.; Mirkin, C. A.

*257<sup>th</sup> ACS National Meeting*, March 31<sup>st</sup>–April 4<sup>th</sup>, 2019. Orlando, FL (Oral talk)

[7] Site-Specific Polymer Nanoreactors for Studying Complex Nanoparticles Using Correlative Electron Microscopy.

**Du, J. S.;** Chen, P.-C.; Dravid, V. P.; Mirkin, C. A.

*2018 MRS Spring Meeting*, April 2<sup>nd</sup>–6<sup>th</sup>, 2018. Phoenix, AZ. (Oral talk)

[8] Using STEM to Probe the in-situ Dynamics of Multimetallic Nanoparticles Grown in Polymer Nanoreactors.

**Du, J. S.;** Chen, P.-C.; Dravid, V. P.; Mirkin, C. A.

*Microscopy & Microanalysis 2017*, August 6<sup>th</sup>–10<sup>th</sup>, 2017. St. Louis, MO. (Oral talk)

[9] Multi-stage Transformation and Lattice Fluctuation at AgCl-Ag Nanoparticle Interface.

**Du, J. S.;** Park, J.; Kim, Q.; Dravid, V. P.; Yang, D.; Weitz, D. A.

*253<sup>rd</sup> ACS National Meeting*, April 2<sup>nd</sup>–6<sup>th</sup>, 2017. San Francisco, CA. (Oral talk)

[10] Surface-embedded Pt/CeO<sub>2</sub> Hybrid Nanostructure with High Catalytic Activity and Thermal Stability.

**Du, J.;** Yu, J.; Bian, T.; Jiang, Y.; Zhang, H.; Yang, D.

*7<sup>th</sup> National Meeting of Undergraduate Innovation and Entrepreneurship*, October 18<sup>th</sup>–19<sup>th</sup>, 2014. Xi'an, China. (Oral talk,

**Outstanding Paper Award)**

► Highlighted by Zhejiang University Undergraduate School News.

[11] Controlled Synthesis of Au and M@Au Nanostars and Their LSPR Properties.

Du, J.; Zhang, H.; Yang, D.

Graduate Joint Forum on Technologies & Sensors, Cyrus Tang Center for Sensor Materials and Applications, Zhejiang University, June 13<sup>th</sup>, 2014. Hangzhou, China. (Poster)

#### **PATENTS AND PATENT APPLICATIONS (PUBLISHED)**

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[1] Polymer-assisted synthesis of ultrasmall nanoparticles.

62/824,617. U.S. Patent Application.

[2] Device and method for fluid flow rate measurement.

CN 103063868. China Patent.

#### **ACADEMIC COMPETITIONS**

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Outstanding Winner, Zhejiang University Challenge Cup Undergraduate Academic Research Contest	2015
Report Title: Platinum-based Nanostructures with High Catalytic Activity and Thermal Stability	
Meritorious Winner, Interdisciplinary Contest in Modeling (MCM/ICM, COMAP)	2014
Report Title: Bibliometrics, Biosystem, Better Choice: The Interdisciplinary Analysis of Network Influence	
First Prize, Kuang-Chi Metamaterials Mathematical Modeling Contest	2013
Report Title: Microstructural Effect on the Electromagnetic Responses of Metamaterials	
First Prize, Chinese Adolescents Science and Technology Innovation Contest	2010
Report Title: Design and Implementation of Quantitative Astronomical Experiments for High School Students	

#### **POPULAR SCIENCE AND SECONDARY EDUCATION ARTICLES**

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*China Science and Technology Education*, 2011 (11), 27–29. *Amateur Astronomer*, 2010 (4), 72–73. *Physics Bulletin*, 2010 (6), 20–24. *Science in 24 Hours*, 2009 (7–8), 13–15. *Science in 24 Hours*, 2009 (7–8), 16–17. *Chinese National Astronomy*, 2009 (7), 110. *Science in 24 Hours*, 2009 (6), 38–39.