

Hao Xu (Alex)

Research Assistant Professor

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EDUCATION & PAST WORK EXPERIENCE

Postdoctoral Research Associate, Washington State University, Pullman, Washington, USA, 10/2022-01/2026

Postdoctoral Research Associate, University of Calgary, Calgary, Alberta, Canada, 09/2019-09/2022

Ph. D., Chemical Engineering and Technology, Tsinghua University, Beijing, P. R. China, 08/2014-07/2019

B. Sc., Chemical Engineering and Industrial Biological Engineering, Tsinghua University, Beijing, P.R. China, 08/2010-07/2014

ACADEMIC SPECIALITY

Over 13-year experience in heterogeneous catalysis and its utilization in industrial processes

Leading efforts of over 10 research programs with strong industrialization potentials including acetylene hydrochlorination, natural gas conversion, heavy & light oil valorization, biofuel upgrading, solid waste utilization, plastic upcycling, automobile exhaust aftertreatment, biomass valorization, integrated capture and conversion of CO₂ into materials (IC3M) and ethanol production from syngas

Heterogeneous catalysis: catalyst synthesis and evaluation, material characterization (XRD, TEM, SEM, XRF, ICP-OES, chemisorption (including TPR, TPD, TPSR, pulse titration), TGA, N₂ adsorption-desorption, IR, Raman, NMR, UV-Vis, XAFS, etc.), kinetic study, reactor simulation and design, industrialization

Model compound and product analysis: GC, GC-MS, elemental analysis, distillate analysis, simulated distillation, density, viscosity, spot test, total acid number, water content, asphaltene content, etc.

Ab initio quantum chemistry by DFT study: proficient use of calculation platforms such as Gaussian, Material Studio and VASP. Study of adsorption energies, reaction mechanisms, transitional states, electron densities and activation energies

Coding experience: Over 15-year experience of using programming languages including Java, Matlab and Python to address computational tasks (e.g. thermodynamic and kinetic fittings, reactor simulations, DFT calculations) and significantly enhance the efficiency of data processing for experimental tasks

TEACHING EXPERIENCE

Invited Lecturer, Chemical Engineering 101, Washington State University, 09/2023-10/2024

Teaching Assistant, Chemical Engineering Field Practice, Tsinghua University, 06/2015-09/2015

Teaching Assistant, Student Research Training, Tsinghua University, 09/2014-06/2019

Teaching Assistant, Unit Operations in Chemical Engineering, Tsinghua University, 09/2014-01/2015

Teaching Assistant, Fluidization Reaction Engineering, Tsinghua University, 09/2013-01/2014

PUBLICATIONS

Journal publications

As first-author:

1. Weixin Huang, **Hao Xu (co-first author)**, Yang Deng, Shih-Wei Lin, Hien N. Pham, Rui Zhang, Dong Jiang, Zihao Zhang, Andrew DeLaRiva, Shuxuan Feng, Yixiao Li, Xinrui Zhang, Abhaya K Datye, Chih-Jung Chen, Yong Wang. Single-atom Zr promoter boosts oxygen activation on ceria-supported Pt catalysts, **Nature Communications**, 2025, 16: 7274
2. **Hao Xu**, Kamran Haddadian, Yimeng Li, Zhaofei Li, Wenping Li, Jack Jarvis, Hua Song. Methane-assisted catalytic light oil desulfurization: catalyst design, sulfur product distribution analysis and mechanistic study. **Chemical Engineering Journal**, 2023, 464: 142648.
3. **Hao Xu**, Mingyuan Cao, Zhaofei Li, Wenping Li, Shijun Meng, Hua Song. Production of Low Carbon Number Olefins from Natural Gas: Methane-involved Catalytic Non-Oxidative Propane Dehydrogenation. **Chemical Engineering Journal**, 2023, 454: 140508.
4. **Hao Xu**, Yimeng Li, Shijun Meng, Lijia Liu, Hua Song. Catalytic elemental sulfur-assisted methane activation at low temperature. **Applied Catalysis B: Environmental**, 2022, 315: 121518.
5. **Hao Xu**, Peng He, Zhaofei Li, Shijun Meng, Yimeng Li, Lo-Yueh Chang, Lijia Liu, Xiaodong Wen, Brittney A. Klein, Vladimir K. Michaelis, Jizhen Qi, Dongchang Wu, Xi Liu, Hua Song. Environmentally benign methane-regulated desulfurization. **Applied Catalysis B: Environmental**, 2022, 312: 121436.
6. **Hao Xu**, Yang Song, Yanyan Zhang, Hua Song. Organic solid waste upgrading under natural gas for valuable liquid products formation: Pilot demonstration of a highly integrated catalytic process. **Bioresource Technology**, 2022, 346: 126645.
7. **Hao Xu**, Yimeng Li, Zhaofei Li, Yang Song, Yanyan Zhang, Hua Song. Methane-assisted waste cooking oil conversion for renewable fuel production. **Fuel**, 2022, 311: 122613.
8. **Hao Xu**, Yang Song, Yanyan Zhang, Hua Song. Catalytic vacuum residue upgrading under methane: Evaluation of process feasibility, stability and versatility. **Fuel**, 2022, 309: 122155.
9. **Hao Xu**, Zhaofei Li, Yimeng Li, Hua Song. The interactive role of methane beyond a reactant in crude oil upgrading. **Communications Chemistry**, 2021, 4: 152.
10. **Hao Xu**, Zhaofei Li, Shijun Meng, Jack Jarvis, Hua Song. Highly selective skeletal isomerization of cyclohexene over zeolite-based catalysts for high-purity methylcyclopentene production. **Communications Chemistry**, 2021, 4: 34.
11. **Hao Xu**, Zhaofei Li, Yimeng Li, Hua Song. Catalytic asphaltene upgrading under methane environment: Solvent effect and its interaction with oil components. **Fuel**, 2021, 291: 120157.
12. **Hao Xu**, Zhaofei Li, Robert L. Pryde, Shijun Meng, Yimeng Li, Hua Song. Participation of methane in an economically and environmentally favorable catalytic asphaltene upgrading process. **Chemical Communications**, 2020, 56: 5492.
13. **Hao Xu**, Baochang Man, Guohua Luo. Catalytic Mechanism Comparison Between 1,2-Dichloroethane-Acetylene Exchange Reaction and Acetylene Hydrochlorination Reaction for Vinyl Chloride Production: DFT Calculations and Experiments. **Catalysts**, 2020, 10(2): 204.
14. Chelsea A. Clark, Prakash C. Reddy, **Hao Xu (Co-first author)**, Kimberly N. Heck, Guohua Luo, Thomas P. Senftle, Michael S. Wong. Mechanistic Insights into pH-Controlled Nitrite Reduction to Ammonia and Hydrazine over Rhodium. **ACS Catalysis**, 2020, 10(1): 494.
15. **Hao Xu**, Guohua Luo. Green production of PVC from laboratory to industrialization: State-of-the-art review of heterogeneous non-mercury catalysts for acetylene hydrochlorination. **Journal of Industrial and Engineering Chemistry**, 2018, 65(1): 13.
16. **Hao Xu**, Shijun Meng, Guohua Luo. Ionic liquids-coordinated Au catalysts for acetylene hydrochlorination: DFT approach towards reaction mechanism and adsorption energy. **Catalysis Science & Technology**, 2018, 8(4): 1176.
17. **Hao Xu**, Jiangkun Si, Guohua Luo. Kinetics model and fixed bed reactor simulation of Cu catalyst for acetylene hydrochlorination. **International Journal of Reactor Engineering**, 2017, 15(4): 1.

18. **Hao Xu**, Jiangkun Si, Kai Zhou, Guohua Luo. A ligand coordination approach for high reaction stability of an Au-Cu bimetallic carbon-based catalyst in the acetylene hydrochlorination process. **Catalysis Science & Technology**, 2016, 6(5): 1357.

As co-author:

19. Shuxuan Feng, Xiong He, Yang Deng, **Hao Xu**, Chaochao Dun, Weixin Huang. Unraveling reaction pathways in CO₂ hydrogenation to methanol at metal-oxide interfaces. **ACS Catalysis**, 2025, 15: 11981.

20. Jack Jarvis, **Hao Xu**, Yimeng Li, Zhaofei Li, Wenping Li, Shijun Meng, Lo-Yueh Chang, Lijia Liu, Hua Song. Methane-assisted Selective Bio-oil Deoxygenation for High-Quality Renewable Fuel Production: A Rational Catalyst Design and Mechanistic Study. **Chemical Engineering Journal**, 2023, 475: 146052.

21. Ali Omidkar, **Hao Xu**, Zhaofei Li, Kamran Haddadian, Hua Song. Techno-economic and life cycle assessment of renewable diesel production via methane-assisted catalytic waste cooking oil upgrading. **Journal of Clean Production**, 2023, 396: 137512.

22. Wenping Li, Mingyuan Cao, Shijun Meng, Zhaofei Li, Hao Xu, Lijia Liu, Hua Song. Non-Thermal Plasma Assisted Catalytic Water Splitting for Clean Hydrogen Production at Near Ambient Conditions. **Journal of Cleaner Production**, 2023, 387:135913.

23. Yimeng Li, **Hao Xu**, Zhaofei Li, Shijun Meng, Hua Song. Catalytic methanotreating of vegetable oil: A pathway to Second-generation biodiesel, **Fuel**, 2022, 311: 122504

24. Shijun Meng, Wenping Li, **Hao Xu**, Zhaofei Li, Yimeng Li, Jack Jarvis, Hua Song. Non-thermal Plasma Assisted Catalytic Reforming of Naphtha and its Model Compounds with Methane at Near Ambient Conditions. **Applied Catalysis B: Environmental**, 2021, 297: 120459.

25. Zhaofei Li, Yimeng Li, **Hao Xu**, Jack Jarvis, Shijun Meng, Hua Song. Effect of methane presence on catalytic heavy oil partial upgrading. **Fuel**, 2021, 297: 120733.

26. Yimeng Li, Peng He, Zhaofei Li, **Hao Xu**, Jack Jarvis, Shijun Meng, Hua Song. Catalytic desulfurization of marine gas oil and marine diesel oil under methane environment. **Fuel**, 2021, 289: 119864.

27. Jia Zhao, Yi Yu, Xiaolong Xu, Shuxia Di, Bolin Wang, **Hao Xu**, Jun Ni, LingLing Guo, Zhiyan Pan, Xiaonian Li. Stabilizing Au (III) in supported-ionic-liquid-phase (SILP) catalyst using CuCl₂ via a redox mechanism. **Applied Catalysis B: Environmental**, 2017, 206: 175

28. Kai Zhou, Jinchao Jia, Chunhua Li, **Hao Xu**, Jun Zhou, Guohua Luo, Fei Wei. Low content Au-based catalyst for hydrochlorination of C₂H₂ and its industrial scale-up for future green PVC process. **Green Chemistry**, 2015, 17(1): 356.

Patents

1. Method of Deoxygenation of a Hydrocarbon in the Presence of Methane-containing Gas Environment and Catalyst Structure. US 63/127,512.

2. Catalytic Desulfurization of Marine Gas Oil and Marine Diesel Oil under Methane Environment. US 63/143,279.

3. Method of Light Oil Desulfurization in the Presence of Methane-containing Gas Environment and Catalyst Structure. US 63/066,855.

4. Method of Asphaltene Upgrading in the Presence of Light Hydrocarbon Gas Environment and Catalyst Structure. US 62/963,759.

5. A metal oxide catalyst for NO removal and its preparation. CN 108636417A.

6. A high-activity and stable copper-based catalyst for acetylene hydrochlorination. CN 107008465A.

7. A metal salt complex catalyst for acetylene hydrochlorination. CN 105126878A.

8. A metal-loaded non-mercury catalyst for acetylene hydrochlorination. CN 104801345A.

Books

1. Hua Song, Jack Jarvis, Shijun Meng, **Hao Xu**, Zhaofei Li, Wenping Li. Methane Activation and Utilization in the Petrochemical and Biofuel Industries. 2020, Springer Nature, Switzerland AG.

PROJECTS

Research Project, Research Assistant Professor, 02/2026-present

Washington State University, Pullman, WA, USA

Supervisor: Prof. Yong Wang

Leader with advising, supervision, management and coordination duties in the following projects:

- Integrated capture and conversion of CO₂ to materials
- Enhancing catalytic performance by effective pretreatments for emission control applications
- Solid waste valorization through catalytic conversions

Postdoc Project, Postdoctoral Research Associate, 10/2022-02/2026

Washington State University, Pullman, WA, USA

Supervisor: Prof. Yong Wang

Leader/main participant in the following projects:

- Carbon dioxide utilization by selective reduction over structure-controlled catalysts
- Highly efficient three-way catalyst for low-temperature oxidation of hydrocarbons
- Catalytic upcycling of plastic waste

Postdoc Project, Postdoctoral Research Associate, 09/2019-09/2022

University of Calgary, Calgary, AB, Canada

Supervisor: Prof. Hua Song

Mitacs Elevate Postdoctoral Fellowship (CA\$60,000/year for 2 years)

Leader/main participant in the following projects:

- Catalytic Biomass Valorization Using Natural Gas (CA\$200,000)
- Catalytic Targeted Upgrading of Extra Heavy Crude under Natural Gas (CA\$50,000)
- Catalytic Valorization of Low-cost Light Hydrocarbon Streams under Methane Environment (CA\$100,000)
- Multifunctional Catalyst Characterization System for Supporting Catalytic Natural Gas Valorization (CA\$150,000)
- Catalytic Valorization of Low-cost Light Crudes under Methane Environment (CA\$200,000)
- Catalytic Upgrading of Extra Heavy Crude Using Natural Gas (CA\$150,000)
- Catalytic Organic Solid Wastes Valorization Using Natural Gas (CA\$200,000)
- Nonthermal Plasma Assisted Catalytic Air Purification and Sanitation at Ambient Conditions (CA\$600,000)

Ph. D. Project, Ph. D. Candidate, 08/2014-07/2019

Tsinghua University, Beijing, P. R. China

Supervisor: Prof. Guohua Luo

Project: High-performance Hg-free Au/C catalyst for acetylene hydrochlorination (CNY 2,000,000)

- Developed Au/C catalyst with an ultra-low gold content (down to 0.05 wt%, close to single atom dispersion) and excellent stability through adding synergistic metal, ligand stabilizer and liquid loading agent
- Carried out a DFT study for a better understanding of the reaction and deactivation mechanism, so that the rationale for catalyst design can be improved
- Performed kinetic study, reactor simulation and reactor design for predicting the catalyst performance in the industry by lab-based data
- Participated in the industrial scale-up of the catalyst system. The prepared low Au content catalyst can be used continuously for 18000 hours on a 4 t/year pilot unit, and the lifetime is 3 times higher than traditional Hg catalysts, manifesting economic advantages for real industrial application

- Further scaling-up to 10,000 t/year demonstration unit is ongoing

Oversea Academic Visiting, Visiting Scholar, 03/2017-09/2017

Rice University, Houston, TX, USA

Supervisor: Prof. Michael S. Wong

- Rh-based catalysts for aqueous nitrite remediation: pH dependence, hydrazine detection and high activity in NaCl solution
- Leading the project for the Nano-Enabled Water Treatment (NEWT) center (over US\$100,000 funded)

Oversea Exchange Program (UTRIP 2013), Participant, 06/2013-08/2013

Tokyo University, Tokyo, Japan

Supervisor: Prof. Tatsuya Tsukuda

- Preparation of dendrimer encapsulated copper nanocluster by a microfluidic method

Conceptual Internship, Participant, 06/2013-07/2013

Tsinghua University, Beijing, China

Supervisor: Prof. Jian Chen

- The mass transport performance of structured packing tower for CO₂ absorption

Physical Experiment Competition, Participant, 06/2011-06/2013

University of Science and Technology Beijing, Beijing, China

Cooperators: Zhenhao Tian, Yuhang Fu

- Measurement of surface tension by the pressure difference of soap bubbles

Student Research Training Program, Leader, 12/2011-05/2013

Tsinghua University, Beijing, China

Supervisor: Prof. Guoqiang Jiang

- Potential and industrial process exploration of microalgae for biofuel production

 **ACADEMIC RECORDS**

Undergraduate: got 179 credits. Ranked top 3 in inorganic and analysis chemistry, biological chemistry, principle of chemical engineering, process system engineering, thermodynamics, instrumental analysis and chemical engineering experiments (GPA Rank 10/109).

Graduate: All courses scored over 90 points out of 100, top 1 in 5 courses (GPA Rank 1/72).

 **AWARDS**

Mitacs Elevate Postdoctoral Fellowship, 09/2020

Gao Yingshi Scholarship, Tsinghua University, 09/2018

The excellent individual in social practice, Tsinghua University, 12/2016

Mei Yiqi Scholarship, Tsinghua University, 09/2016

Sino Petro Scholarship for excellent students, Tsinghua University, 09/2015

The excellent individual in summer vacation social practice, Department of Chemical Engineering, Tsinghua University, 09/2015

Excellent undergraduate student, Tsinghua University, 07/2014

Excellent graduation thesis of undergraduate students, Tsinghua University, 06/2014

Baogang Scholarship for excellent students, Tsinghua University, 06/2013

Scholarship for technological innovation, Tsinghua University, 06/2013

First prize, 1st Innovation Competition of Engineering Ability, Tsinghua University, 12/2012

Scholarship for good academic records, Tsinghua University, 06/2012

1st prize, 30th Extracurricular Academic and Technology Work Competition of Tsinghua University, Tsinghua University, 04/2012

1st prize, 2011 Beijing Physical Experiment Competition, Beijing, 03/2012

SKILLS

Language: IELTS 8.0 (top 1% among Chinese native speakers)

Computer: C++, Java, software development for Android platform, proficient operation of Aspen, Matlab, Polymath, Lingo, Origin, Photoshop, Cool Edit, Solidwork, Corel Videostudio, etc.

Sports: Jogging, swimming, ping-pong, badminton, etc.

Speaking: 3rd prize in the speech contest at Tsinghua University

SELF EVALUATION

Sound experience in catalyst study from both academic and industrial perspectives, self-motivated, open-minded, perseverance, optimism, enthusiasm, and devotion to fresh things

Motto from Tsinghua University: Actions speak louder than words!