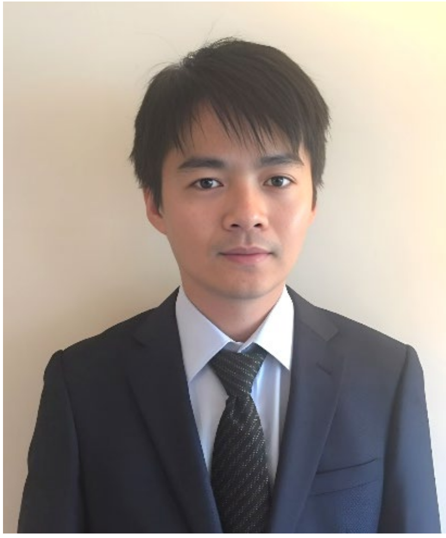
ACADEMIA SINICA
EARLY-CAREER INVESTIGATOR
RESEARCH ACHIEVEMENT AWARD



楊 東 翰

國立清華大學化學工程學系副教授

代表著作：

- Yi-Hong Liu, Chia-Jui Hsieh, Liang-Ching Hsu, Kun-Han Lin, Yueh-Chun Hsiao, Chong-Chi Chi, Jui-Tai Lin, Chun-Wei Chang, Shang-Cheng Lin, Cheng-Yu Wu, Jia-Qi Gao, Chih-Wen Pao, Yin-Mei Chang, Ming-Yen Lu, Shan Zhou, and **Tung-Han Yang**, 2023, Toward Controllable and Predictable Synthesis of High-Entropy-Alloy Nanocrystals. *Science Advances*, 9, eadf9931.
- Cheng-Yu Wu, Yueh-Chun Hsiao, Yi Chen, Kun-Han Lin, Tsung-Ju Lee, Chong-Chi Chi, Jui-Tai Lin, Liang-Ching Hsu, Hsin-Jung Tsai, Jia-Qi Gao, Chun-Wei Chang, I-Ting Kao, Chia-Ying Wu, Ying-Rui Lu, Chih-Wen Pao, Sung-Fu Hung, Ming-Yen Lu, Shan Zhou, and **Tung-Han Yang** , 2024, A Catalyst Family of High-Entropy-Alloy Atomic Layers with Square Atomic Arrangements Comprising Iron- and Platinum-Group Metals. *Science Advances*, 10, eadl3693.
- Shang-Cheng Lin, Chun-Wei Chang, Meng-Hsuan Tsai, Chih-Hao Chen, Jui-Tai Lin, Chia-Ying Wu, I-Ting Kao, Wen-Yang Jao, Chia-Hsin Wang, Wen-Yueh Yu, Chi-Chang Hu, Kun-Han Lin and **Tung-Han Yang**, 2024, Decreasing the O_2-to-H_2O_2 Kinetic Energy Barrier on Dilute Binary Alloy Surfaces with Controlled Configurations of Isolated Active Atoms. *Advanced Functional Materials*, 34, 2314281.

簡評：

楊老師的研究具高度原創性與國際領先性，成功開創高熵合金奈米晶體設計與應用的新典範，奠定其在多金屬催化領域的全球領導地位，為能源轉換材料設計帶來突破性進展。

簡歷：

楊東翰博士於 2017 年自國立清華大學材料系博士班畢業，博士期間及博士後階段赴美國喬治亞理工學院擔任為期三年半的訪問學者與博士後研究員。2021 年 2 月起任職於國立清華大學化學工程學系，2024 年 8 月升等為副教授。研究專長為多元高熵合金奈米晶體的合成與催化應用，致力於建構高熵奈米晶體庫，成功開發數十種具可調控化學組成、晶體結構、表面原子排列與幾何對稱性的多元材料，並成功應用於能源轉換與電催化反應領域。近年來，榮獲國家科學及技術委員會吳大猷先生紀念獎、臺灣觸媒學會優秀青年獎章、界面科學學會優秀年輕學者獎、李長榮學術研究傑出青年教授獎，以及國立清華大學新進人員研究獎等多項肯定。

Dr. Tung-Han Yang received his PhD from the Department of Materials Science and Engineering at National Tsing Hua University (NTHU) in 2017. During his doctoral and postdoctoral periods, he spent three and a half years at the Georgia Institute of Technology in the United States as a visiting scholar and post-doctoral researcher. He joined the Department of Chemical Engineering at NTHU as an Assistant Professor in February 2021 and was promoted to Associate Professor in August 2024. His research expertise lies in the synthesis and catalytic applications of multicomponent high-entropy alloy nanocrystals. He is dedicated to building a comprehensive library of high-entropy nanocrystals, having successfully developed dozens of novel materials with tunable chemical composition, crystal structure, surface atomic arrangement and geometric symmetry, and applied them in energy conversion and electrocatalytic reaction fields. In recent years, he has received several honours including the Ta-You Wu Memorial Award, the Outstanding Young Scholar Award of the Catalysis Society of Taiwan, the Outstanding Young Scholar Award of Taiwanese Colloid and Interface Society, the LCY Outstanding Young Research Professor Award, and the Outstanding New Faculty Research Award of NTHU.

代表作簡介：

高熵合金由五種或更多元素組成，形成原子級隨機混合的固溶體，其成長過程高度不可預測。我們定量解析五種金屬前驅物在合成過程中的還原速率，並結合數學模型模擬混合熵隨時間變化，成功預測與合成多種具可控組成與結構的高熵奈米晶體，成果發表於 *Science Advances*, 2023。我們緊接發展磊晶成長策略，建立十種不同組成的五元鐵系高熵奈米晶體家族，並結合變溫電子顯微鏡與同步輻射技術，深入探討其相變行為及多原子間的協同催化效應，成果再度刊登於 *Science Advances*, 2024。藉由此材料開發平台，後續進一步實現對高熵奈米晶體原子排列與對稱性的一系列調控，並首度探討其高

熵晶面對異相催化性能與反應機制的關鍵影響，充分展現高熵材料在催化領域的應用潛力與科學研究價值。

High-entropy alloys (HEAs), composed of five or more elements, form atomically random solid-solution phases with inherently unpredictable growth behaviors. Our team was the first to quantitatively analyze the reduction kinetics of five distinct metal precursors during synthesis and to couple these results with a mathematical model simulating the evolution of mixing entropy over time. This approach enabled the successful synthesis of a variety of HEA nanocrystals with controllable compositions and structures, as reported in *Science Advances*, 2023. Building upon this foundation, we further developed an epitaxial growth strategy to construct a family of ten iron-group-metal-based quinary HEA nanocrystals with distinct compositions. Through variable-temperature transmission electron microscopy and advanced synchrotron-based techniques, we systematically investigated their phase transformation behaviors and multimetallic synergistic effects on catalytic activity, with findings published in *Science Advances*, 2024. Leveraging this materials development platform, we subsequently achieved precise control over the atomic arrangement and symmetry of HEA nanocrystals and, for the first time, elucidated the facet-dependent catalytic performance and underlying mechanisms in heterogeneous catalysis. These studies collectively highlight the potential and significance of HEA nanomaterials in energy-related catalytic applications.

得獎感言：

非常感謝中央研究院與評審委員的肯定，也感謝國家科學及技術委員會與國立清華大學化工系提供自由創新的研究環境。清大高熵材料研發中心與國家同步輻射研究中心亦提供了關鍵資源與平台，促成與眾多優秀團隊的合作與交流。能投入多元奈米晶體設計與催化應用這片充滿挑戰的領域，有賴於清華的開放精神與學生們的全力投入。衷心感謝所有合作夥伴、同事、家人，特別是太太長期以來的支持與包容。未來我將持續精進研究，努力在高熵材料與催化領域開創更多突破。

I am deeply grateful to Academia Sinica and the review committee for their recognition, and to the National Science and Technology Council and the Department of Chemical Engineering at NTHU for providing a free and innovative research environment. The High-Entropy Materials Research Center and the National Synchrotron Radiation Research Center have provided essential resources and platforms that have facilitated meaningful collaborations with numerous outstanding research teams. My ability to explore the challenging field of multicomponent nanocrystal design and catalytic applications has been made possible by the open academic spirit of NTHU and the wholehearted dedication of my students. I sincerely thank all my collaborators, colleagues, and my family, especially my wife, for their long-standing support and understanding. Looking ahead, I will continue to advance my research and strive for further breakthroughs in high-entropy materials and catalysis.