

A MICROALGAE PLATFORM FOR CARBON CAPTURE/UTILIZATION AND CARBON CIRCULARITY

Speaker

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Abstract

The global transition toward carbon neutrality requires not incremental improvements, but a fundamental transformation in how carbon capture, utilization, and storage (CCUS) are conceived and implemented within industrial systems. Microalgae represent a high-efficiency biological platform with the potential to redefine carbon management through true carbon circularity, leveraging photosynthetic CO₂ fixation rates that significantly exceed those of terrestrial plants. By directly assimilating carbon from atmospheric air, industrial flue gas, and biogas streams, these microorganisms transform waste emissions into a versatile biomass reservoir - a feedstock for biofuels, high-value biochemicals, and durable bioplastics - thereby extending carbon residence time across global value chains. This lecture details the transition of microalgal carbon capture and utilization (CCU) from experimental concepts to industrial-scale reality, centered on the operational milestones of the world's first ton-scale microalgal CCU facility utilizing steel plant blast furnace emissions, followed by the deployment of hectare-scale biorefinery pilot systems. We will examine critical advances in overcoming gas-liquid mass-transfer limitations through bicarbonate-mediated capture and hybrid physicochemical-biological processes, alongside the development of engineered microalgae-bacteria consortia for simultaneous carbon sequestration and wastewater nutrient recovery. By integrating microbial biotechnology with advanced process engineering and techno-economic optimization, this presentation provides a strategic roadmap for evolving pilot demonstrations into integrated industrial ecosystems, illustrating how biological innovation can accelerate the global transition toward carbon-negative biomanufacturing and sustainable industrial transformation.

Biography

Professor Jo-Shu Chang is the Chair Professor and Vice President of Tunghai University and also serves as an Emeritus Chair Professor at National Cheng Kung University (NCKU) in Taiwan. He obtained his Ph.D. from the University of California, Irvine in 1993. Between 2019 and 2021, he was recognized as a Highly Cited Researcher by the Web of Science Group. He has been included in Stanford University's list of the world's top 2% scientists from 2020 to 2024. Additionally, Professor Chang ranked No. 1 in Taiwan's Biology and Biochemistry category for 2021-2025 (Research.com). His research interests cover biochemical engineering, environmental biotechnology, and applied microbiology, with a recent focus on utilizing microalgae for CO₂ capture and conversion into biofuels and biorefineries. In 2009, he established the world's first microalgae-based carbon capture and utilization pilot plant at China Steel Co. (CSC), capturing flue gas from the blast furnace of the CSC factory. He also built a microalgae cultivation and biorefinery plant at NCKU featuring large-scale systems and advanced microalgae technologies from upstream to downstream. In the 2010s, his team constructed a 2,000-ton microalgae-based swine wastewater treatment plant, converting the microalgal biomass generated from wastewater into fertilizers and aquaculture feed. His publication in the microalgae category ranked No. 1 globally (WoS). He served as President of Taiwan's Society of Biotechnology and Biochemical Engineering (BEST) from 2019 to 2022. Furthermore, he is the principal investigator of Taiwan's National Energy Project, leading a world-class team specializing in microalgae biorefinery and bio-based CO₂ utilization. He also leads the Negative Carbon Technology and Biomass Energy task groups for Taiwan's 2050 Net Zero Pathway Task Forces. Professor Chang has received numerous prestigious awards, including three Distinguished Research Awards from Taiwan's National Science and Technology Council. Since 2015, he has been a Fellow of the American Institute of Medical and Biological Engineering (AIMBE), and since 2018, he has been a Fellow of the International Forum of Industrial Bioprocessing (IFIBiop). He has also served as Editor or Associate Editor for five renowned international journals and as an editorial board member for nearly 10 SCI-indexed journals. His academic contributions are reflected in his extensive publication records, comprising over 850 SCI-indexed journal papers (including 28 ISI Hi-Ci papers), with a total of 88,613 citations (Google Scholar). His h-index stands at an impressive 156 (Google Scholar). In addition, he has authored 15 book chapters, holds nearly 50 patents, and has over 10 technical transfers, with several research findings successfully applied in industry and commercialized. He also owns a venture company focused on microalgae-based biofuels and biorefineries, which has received significant investment from Taiwan's Formosa Group.



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