



## Department of Materials Science and Engineering Seminar Series 2025

# Vanadium-Mediated Electrochemical-Chemical (Photocatalytic) Cycle for Value-Added Chemical Synthesis

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Date and time: 07<sup>th</sup> April 2026, 3:00pm – 5:00pm

Venue: EA-02-14

### Abstract

The growing demand for sustainable energy storage and green chemical production highlights the limitations of conventional energy conversion and storage technologies. This thesis introduces vanadium-mediated strategies for value-added chemical synthesis through the design of integrated electrochemical–chemical and electrochemical–photocatalytic cycles.

Using the  $\text{VO}_2^+/\text{VO}^{2+}$  and  $\text{V}^{3+}/\text{V}^{2+}$  redox couples as mediators, the work demonstrates: (i) photocatalytic oxygen evolution reaction driven by solar energy, where  $\text{VO}_2^+$  acts as an efficient electron acceptor to enhance charge separation in  $\text{TiO}_2$ -based photocatalysts; (ii) selective oxidation of benzyl alcohol to benzaldehyde, catalysed by a suitable catalyst and mediated by the  $\text{VO}_2^+/\text{VO}^{2+}$  redox couple, achieving >99% selectivity and Faradaic efficiencies exceeding 95% over multiple cycles; and (iii) system designs enabling  $\text{V}^{2+}$ -mediated hydrogen evolution and the reduction of cinnamaldehyde.

By integrating these reactions within a single vanadium redox flow battery framework, the proposed approach enables decoupled water splitting and benzyl alcohol splitting, providing spatial and temporal flexibility, reduced overpotentials, and improved operational stability compared with conventional electrolyzer systems.

Overall, this research establishes a versatile redox-mediated platform that links energy storage with chemical synthesis, offering a scalable pathway toward integrated renewable energy utilization and sustainable chemical manufacturing.

## **Biography**

Yan Jingkai received his bachelor's degree from University of Victoria (UVic). He is currently a Ph.D. candidate in the Department of Materials Science and Engineering at the National University of Singapore under the supervision of Prof. Wang Qing. His research focuses on the development of redox-mediated strategies for chemical synthesis by integrating electrochemical processes with chemical and photocatalytic reactions.

**Please join us!**

HOST: Asst Prof Zhong Peichen