



# ACMME 2023

**The 11th Asia Conference on Mechanical and Materials Engineering**

## ICCBS 2023

**2023 10th International Conference on Chemical and Biological Sciences**

**Sapporo, Japan | June 8-11, 2023**



## Session 3-A

### Topic: Applied Catalysis, Material Chemistry, and Material Physics

Session Chair: Prof. Jia-Lin Tsai, National Yang Ming Chiao Tung University, Taiwan

Time: 16:15-17:30, June 9, 2023

Onsite Room: 5D

16:15-16:30	<p><b>MS23-6227-A</b></p> <p><b>Identifying the True Active Species in Ru-based Polymetallic Hydroxide toward Alkaline Hydrogen Evolution</b></p> <p><b>Presenter: Dan Li</b></p> <p>Dan Li, Chao Huang and Paul K. Chu</p> <p>City University of Hong Kong, China</p>
16:30-16:45	<p><b>MS23-1242</b></p> <p><b>Decolorization Kinetics of Azo Dye (Methyl Orange) in Fenton process with High Entropy Alloys as Catalyst</b></p> <p><b>Presenter: Norhuda Hidayah Nordin</b></p> <p>Nur Hudawiyah Abu Hassan, Nor Akmal Fadil, Nur Ayuni Jamal, Farah Diana Daud and Norhuda Hidayah Nordin</p> <p>International Islamic University Malaysia, Malaysia</p>
16:45-17:00	<p><b>MS23-6126-A</b></p> <p><b>Fabrication and Hydrogen Permeation Resistance of dense CrN coatings</b></p> <p><b>Presenter: Qingdong Ruan</b></p> <p>Qingdong Ruan and Paul K. Chu</p> <p>City University of Hong Kong, China</p>
17:00-17:15	<p><b>MS23-1071-A</b></p> <p><b>Effects of Doping and Vacancies in the Electronic Properties of the SiC Monolayer: A DFT Approach</b></p> <p><b>Presenter: Lucia G Arellano Sartorius</b></p> <p>Lucia G Arellano Sartorius, Ranferi Cancino, Francisco De Santiago, Álvaro Miranda and Jun Nakamura</p> <p>Instituto Politécnico Nacional, Mexico</p>

# Identifying the True Active Species in Ru-based Polymetallic Hydroxide toward Alkaline Hydrogen Evolution

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Ruthenium (Ru)-based electrocatalyst used for hydrogen evolution reaction (HER) has been greatly explored since its similar bond strength with hydrogen as Pt but less expensive price relatively [1]. However, exact identification of true active sites of Ru-based composite still needs to be discussed [2].

Herein, we report that the Ru clusters will be electrochemically leached onto the surface of  $\text{RuMO}_x\text{H}_y$  (M means transition metals) under a weak HER cathodic potential through an in-situ surface reconstruction phenomenon. Using a post-catalytic analysis, we interrogate the composition and microstructure of its reduced counterpart and conclude that the produced metallic Ru should be the true active species to enhance the HER activity in both neutral and alkaline media. In addition, among various  $\text{RuMO}_x\text{H}_y$ , the as-resulted  $\text{Ru/NiFeRuO}_x\text{H}_y$  exhibits the best HER performance, which only requires 30 mV and 50 mV overpotential to drive a  $10 \text{ mA cm}^{-2}$  current density in alkaline and neutral media, respectively. The fast reaction kinetics ( $30 \text{ mV decade}^{-1}$  in alkaline media and  $42 \text{ mV decade}^{-1}$  in neutral media) and outstanding stability of  $\text{Ru/NiFeRuO}_x\text{H}_y$  guarantee that it is a promising HER catalyst for practice application. The DFT calculation further confirms that the formed Ru clusters with 0 valence state can effectively accelerate the process of H combination and  $\text{H}_2$  desorption, which reduce the energy barriers of overall HER. We believe this interesting phenomenon and excellent HER activity of as-resulted hybrid catalyst in this work will greatly conduce to the understanding of catalysis and development of highly active electrocatalyst in water-splitting, fuel cells and other heterogeneous catalytic reactions.

## References

- [1] Y. Liu, S. Liu, Y. Wang, Q. Zhang, L. Gu, S. Zhao, D. Xu, Y. Li, J. Bao, Z. Dai, Ru modulation effects in the synthesis of unique rod-like  $\text{Ni@Ni}_2\text{P-Ru}$  heterostructures and their remarkable electrocatalytic hydrogen evolution performance, *J. Am. Chem. Soc.* 140 (2018) 2731–2734.
- [2] D. Li, B. Zhang, Y. Li, R. Chen, S. Hu, H. Ni, Boosting hydrogen evolution activity in alkaline media with dispersed ruthenium clusters in NiCo-layered double hydroxide, *Electrochem. Commun.* 101 (2019) 23–27.

## *Acceptance Notification and Invitation Letter*

The 11th Asia Conference on Mechanical and Materials Engineering (ACMME 2023)

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City University of Hong Kong, China

**Dear Dan Li, Chao Huang and Paul K. Chu**

We are pleased to inform you that, after review (please refer to the attached file), your abstract identified below has been accepted for Oral Presentation Only by **The 11th Asia Conference on Mechanical and Materials Engineering (ACMME 2023) to be held in Sapporo, Japan from 8-11 June 2023.**

**Abstract ID: MS23-6227-A**

**Title: Identifying the True Active Species in Ru-based Polymetallic Hydroxide toward Alkaline Hydrogen Evolution**

You are sincerely invited to present your work and communicate with other distinguished participants at the conference.

For registration details, please refer to the second page of this document.

Yours sincerely,  
ACMME 2023 Organizing Committees  
March 16, 2023

