PRATIK VIJAYSINH MANE, Ph.D.

G-LAMP Postdoctoral Researcher | Chemical Engineering

Chonnam National University, Gwangju, Republic of Korea

RESEARCH & COLLABORATION PROFILE

Keywords: Photoelectrochemical Water Splitting | Solar Hydrogen | $BiVO_4$ | Molecular Cocatalysts | CO_2 Reduction | Impedance Spectroscopy



Research at a Glance: Dr.Mane's research focuses on engineering semiconductor–cocatalyst interfaces for efficient solar-driven hydrogen production, with particular emphasis on $BiVO_4$-based photoanodes, advanced cocatalyst integration, and potential-resolved impedance modeling to elucidate interfacial charge-transfer dynamics. His complementary research encompasses electrochemical CO_2 reduction, functional nanomaterials, and the development of sustainable photoelectrochemical energy conversion systems.

RESEARCH EXPERTISE

• **Solar-driven hydrogen production**: design and optimization of $BiVO_4$, TiO_2, and ZnO photoelectrodes for photoelectrochemical water oxidation.

• **Interface engineering:** NiCo-/NiFe-layered double hydroxides, hydroxylation, and molecular cocatalysts to improve charge separation and oxygen evolution.

• **Advanced electrochemical analysis:** potential-dependent EIS, Mott–Schottky analysis, IPCE, ABPE, and reaction kinetics.

• **Electrocatalytic CO_2 conversion: CuS**/Cu gas-diffusion electrode architectures and morphology-controlled catalytic selectivity.

• **Materials synthesis and characterization:** hydrothermal growth, electrodeposition, MOCVD, XPS, XRD, SEM/TEM, Raman, UV–Vis, PL/TRPL, and gas chromatography.

RECENT RESEARCH HIGHLIGHTS

• $BiVO_4$/quercetin-coordinated Ni–Co complex (Journal of Energy Chemistry, 2026): photocurrent 3.081 mA cm^{-2} at 1.23 V vs RHE versus 0.77 mA cm^{-2} for pristine $BiVO_4$; ABPE 1.32%; evaluated 48 h stability.

• TiO_2 nanorods/NiCo-LDH/hydroxylation (International Journal of Hydrogen Energy, 2025): photocurrent increased from 0.56 to 1.46 mA cm^{-2}; 96% retention over 20 h.

• Metal oxide photoanodes interfacial dynamics (ongoing): Operando PEIS analysis for distributed interfacial charge transfer kinetics, recombination, and charge-separation contributions.

• Ni/Co-based metallocyclic supramolecular catalyst/$BiVO_4$ (ongoing): separately developed components; immobilization and integrated PEC evaluation are the next research stages.

POTENTIAL COLLABORATION RESEARCH

Best-fit areas: Solar fuels | Semiconductor interfaces | Catalysis | Photo/electrochemistry | Advanced spectroscopy | Sustainable materials

• **1. Joint photoelectrode development:** engineer semiconductor/LDH and semiconductor/molecular-catalyst interfaces for higher solar water-oxidation efficiency.

• **2. Mechanistic characterization:** Operando PEIS, spectroscopy, and computational insights to resolve interfacial charge-transfer pathways.

• **3. CO_2-to-value-added products:** develop structured Cu-based electrodes and connect morphology, active sites, and product selectivity.

• **4. Scale-up and demonstration:** Investigate stable, low-cost solar-hydrogen devices, integrated photoelectrochemical modules, and field-relevant operating conditions.

SELECTED RESEARCH OUTPUTS

• Journal of Energy Chemistry- Flavonoid-coordinated Ni–Co bimetallic complex-modified $BiVO_4$ photoanodes.

• International Journal of Hydrogen Energy - Hydroxylated TiO_2 nanorod/NiCo-LDH photoanode for improved PEC water oxidation (accepted).

• Renewable & Sustainable Energy Reviews - First-author review research on sustainable energy materials.

• Advanced Sustainable Systems - First-author research selected for journal cover artwork.

• Small; Materials Science and Engineering: R - Additional collaborative publications.

• Research record: approximately 25+ papers, 10+ first-author Q1 SCIE articles, 10+ conference presentations, 8+ awards, and two Korean patent applications.

ACADEMIC BACKGROUND & RESEARCH NETWORK

• Ph.D., Chemical Engineering, Chonnam National University (2025)

• G-LAMP postdoctoral research since December 2024; Advisors: Prof. Jun-Seok Ha and Prof. Sang Hyun Lee

• Research collaborations include KOPTI, KICET, and University of Ulsan.

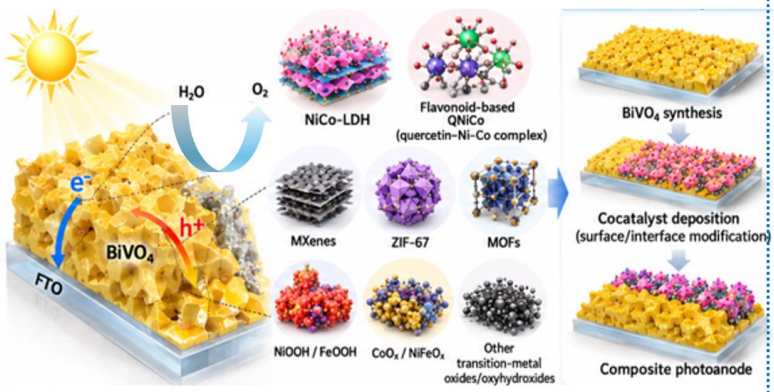
CONTACT / RESEARCH PROFILE

Google Scholar:
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Current Research & Future Perspectives

Photoelectrode Surface/Interface Engineering



Future Aspects: Integrated Solar-Hydrogen System



- ✓ Stable and efficient solar-driven photoelectrodes
- ✓ Scalable fabrication strategies
- ✓ Integrated water-splitting system and hydrogen production
- ✓ Toward commercial solar-hydrogen applications