The HKUST Energy Institute 香港科大能源研究院

中國科學院長春應用化學研究所-香港科技大學 CIAC-HKUST
氫能聯合實驗室 Joint Laboratory for Hydrogen Energy

Joint Workshop

Renewable Energy and Sustainability

Date 31 December 2024 (Monday)
Time 10 am – 12 pm
Venue Chen Kuan Cheng Forum (LTH),
(near Lifts 27-28), HKUST, (**Location**)

Program

Time	
10:00 – 10:40	**Exploring the Flatland of Bi-dimensional Materials for Energy and (opto)Electronics** **Prof. Teresa Gatti** Full Professor of Chemistry for Applied Technologies Politecnico di Torino, Italy
10:40 – 11:20	**The Electrode/Electrolyte Interface Study during the Electrochemical CO2 Reduction in Acidic Electrolytes** **Prof. Yao Yao** Assistant Professor Department of Chemistry Great Bay University (GBU), China
11:20 – 12:00	**BiOI for Photoelectrocatalytic Oxygen Evolution: a surface chemistry analysis and improvement in photoanode fabrication** **Dr. Mengjiao Wang** Post-doctoral Fellow Department of Applied Science and Technology (DISAT) Politecnico di Torino, Italy
12:00	End of the Program

Prof. Teresa Gatti
Full Professor of Chemistry for Applied Technologies
Politecnico di Torino, Italy

Teresa Gatti is Full Professor of Chemistry for Applied Technologies at Politecnico di Torino, Italy. She was a previous Group Leader at the Center for Materials Research of the Justus Liebig University Giessen (Germany), where she maintains the permanent role of affiliated researcher. She is recipient of the 2021 European Research Council Starting Grant with a project on Janus 2D materials. With her team in Italy and in Germany, she works on the synthesis and characterization of novel low-dimensional systems for use in energy-related and (opto)electronic applications, with major focus on sustainability. She is associate editor of the Springer Nature journal npj 2D Materials and Applications.

Exploring the Flatland of Bi-dimensional Materials for Energy and (opto)Electronics

Abstract

Layered materials have many potentials for use in applications requiring (semi)conducting behavior, coupled to anisotropy or preferential orientations. In our group, we try to incorporate them into energy devices of different types, ranging from solar and photoelectrochemical cells up to energy-storage and piezoresistive systems.

In general, we choose to resort to highly scalable methods for their production and their processing, mostly solution-based, through the preparation of inks that can undergo further chemical processes or be deposited via spin/spray/dip-coating.

In this talk, we will give a collective view of some of the recent projects we are carrying on: we will talk about lead-free 2D perovskites and their application in solar cells and will discuss some uses of 2D transition metal dichalcogenides in electrochemical capacitors. We will show some recent results in the production and testing of layered heterojunctions based on two different semiconductors for use in photoelectrochemical hydrogen evolution. Finally, we will shift the focus on describing the potential of hydrogels containing 2D MoS_2 for use in bio-compatible piezoresistive pressure sensors.

Prof. Yao Yao
Assistant Professor
Department of Chemistry
Great Bay University (GBU), China

Dr. Yao Yao obtained her PhD from the Department of Chemical and Biological Engineering (CBE) at HKUST in 2020. Following this, she conducted postdoctoral research at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland before becoming an Assistant Professor at Great Bay University (GBU) in June 2023. Dr. Yao's research now focuses on studying electrode/electrolyte interfaces during electrochemical reactions, particularly electrochemical CO2/N2 reduction.

The Electrode/Electrolyte Interface Study during the Electrochemical CO2 Reduction in Acidic Electrolytes

Abstract

Electrochemical CO2 Reduction (CO2R) in acidic electrolytes has gained significant attention due to its higher carbon efficiency and stability compared to alkaline counterparts. In this system, the proton source for CO2R is a crucial issue that affects our understanding of the rate-determining step (RDS) of CO2R. While H+ is often considered the primary proton source, H2O should also be taken into account—a factor rarely discussed in previous studies.

In this study, we applied an Au-Au rotating ring disk electrode (RRDE) and surface-enhanced infrared absorption spectroscopy (SEIRAS) techniques to study the electrode/electrolyte interface during CO2R and hydrogen evolution reaction (HER) in acidic electrolytes. RRDE results clearly illustrated that CO2R prefers occurring on alkaline/neutral interface, even in acidic electrolyte, indicating that the proton source for CO2R comes from H2O, not H+. In the SEIRAS measurements, it provides direct evidence that the solvated CO2, or CO2(aq), is the actual reactant for CO2R. RRDE results indicated that the CO formation current was positively correlated with the rotating rates in both acidic, neutral, and KHCO3 electrolytes, indicating that the CO2R performance is impacted by the mass transfer of CO2(aq) under experimental conditions.

Dr. Mengjiao Wang
Post-doctoral Fellow
Department of Applied Science and Technology (DISAT)
Politecnico di Torino, Italy

Dr. Mengjiao Wang is a postdoc at the Department of Applied Science and Technology (DISAT) at Politecnico di Torino in Italy. Prior to this role, she held postdoctoral positions at the Istituto Italiano di Tecnologia in Genova, Italy, and the Center for Materials Research at Justus Liebig University in Giessen, Germany. She earned her MSc degree in Materials Physics & Chemistry from the University of Science and Technology of China and completed her PhD in science and technology of chemistry and materials at the University of Genoa. Her research is primarily focused on synthetic methodologies of nanomaterials, photoelectrochemistry, and heterojunction technology. She is a winner of the " Bando TRAPEZIO - Paving the way to research excellence and talent attraction" project. Her project aims to develop 2D heterojunctions for applications in photoelectrocatalysis.

BiOI for Photoelectrocatalytic Oxygen Evolution: a surface chemistry analysis and improvement in photoanode fabrication

Abstract

BiOI is recognized as a promising photoelectrocatalyst for oxidation reactions, yet its limited photoelectrocatalytic (PEC) activity necessitates innovative strategies to modify its surface chemistry and enhance its PEC properties. In this study, we present a straightforward method to increase photocurrent by exfoliating BiOI microspheres produced through a microwave reaction. Following exfoliation in isopropanol, the BiOI layered materials exhibit a broader range of species, including $Bi_2O_2CO_3$, I^-, IO_3^-, Bi^{5+}, and hydroxide species, compared to the original BiOI. These additional species do not directly enhance the PEC oxygen evolution reaction (OER) performance but are consumed or transformed during PEC OER. This process results in more active sites and reduced resistance, ultimately improving the OER performance of the exfoliated BiOI. Moreover, we developed SILAR method to fabricate BiOI photoelectrode with TiO_2 as a protection layer. In testing the photoelectrochemical performance of the BiOI/TiO_2 photoelectrodes, the highest photocurrent (44 μA cm^{-2}) is found for a heterojunction with a BiOI thickness of 320 nm. Additionally, a further protective TiO_2 ultrathin layer in contact with BiOI, grown by atomic layer deposition, enhances the durability and efficiency of the photoanode, resulting in a more than two-fold improvement in photocurrent after 2 hours of continuous operation. This study advances the automation in the sustainable production of photoelectrode films and provides inspiration for further developments in the field.