# Dual-Function Bi-Based Electrodes for Coupled $CO_2$ Reduction and Glycerol Oxidation

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**Significance and Relevance**

These Bi-based electrodes enable simultaneous electrochemical $CO_2$ reduction ($CO_2RR$) and glycerol oxidation (GOR), leveraging a dual-function catalytic system that increases efficiency and selectivity for both reactions. These electrodes enhance the catalytic pathway for $CO_2$-to-formate conversion and effectively utilize GOR alongside $CO_2RR$. These electrodes are used in a single reaction system, and to our knowledge, this is the first time they are utilized in dual-function systems, which enhance reaction performance. Coupling GOR with $CO_2RR$ is an efficient way to use a waste byproduct (glycerol, from biodiesel production) while generating valuable chemicals like formate. This integrated approach aligns with circular economic principles by combining waste utilization and chemical synthesis.

*Preferred and 2nd choice for the topic: Integrated $CO_2$ Reduction and Glycerol Oxidation on Bi-Based Electrodes for Enhanced Efficiency as A Sustainable Approach*
*Preferred presentation*: Poster presentation

**Introduction and Motivations**

The simultaneous electrochemical reduction of $CO_2$ and oxidation of glycerol presents a sustainable pathway for producing valuable chemicals while addressing $CO_2$ emissions and waste glycerol utilization from biodiesel production[1]. Traditional $CO_2$ reduction systems often suffer from high energy demands and limited selectivity but coupling it with glycerol oxidation offers enhanced reaction efficiency and selectivity for desired products[2]. Recent studies on Bi-based catalysts have shown promising performance, particularly in stabilizing intermediates critical for selective formate production, motivating the development of dual-function systems for improved catalytic performance[3].

**Results and Discussion**

In this study, $Bi_2S_3$ nanoplates were synthesized on copper foam and electrochemically reduced to Bi nanoplates, which showed strong adherence to the substrate and high selectivity for formate ($HCOO^-$) production during $CO_2$ reduction. The Cu foam/Bi catalyst achieved a high Faradaic efficiency at a low overpotential. In an electrochemical system, this catalyst was paired with a modified $BiVO_4$ photoanode for glycerol oxidation, enabling simultaneous $CO_2$ reduction and glycerol oxidation under simulated solar irradiation. This research highlights the potential of $Bi_2S_3$-derived Bi nanoplates on copper foam as effective dual-function catalysts for $CO_2$ reduction and glycerol oxidation. The findings showcase the catalyst's stability and selectivity, paving the way for sustainable $CO_2$ utilization and the use of waste glycerol as a co-reactant in integrated electrocatalytic systems.

**References**

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2. A. Kormányos, et al. ACS Catal. 2024, 14, 9, 6503–6512
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