

VISIBLE LIGHT-DRIVEN CONVERSION OF CO₂ OVER Cu₂O/MXene COMPOSITES

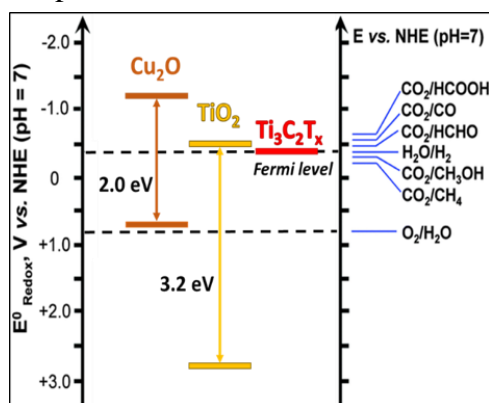
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This research focuses on converting carbon dioxide, a prominent greenhouse gas, into value-added products through photo-electrocatalytic processes. We investigate Cu₂O as our primary photoresponsive material due to its ability to be activated by visible light and its suitable redox potential for CO₂ conversion. Our approach seeks to address key challenges with Cu₂O, such as photocorrosion and rapid charge recombination. To this end, we examined *p,n*-heterojunction semiconductors composed of Cu₂O and TiO₂, incorporating non-precious-metal-based co-catalysts, specifically MXenes (Scheme 1).¹

Treating MXenes, particularly Ti₃C₂T_x, at temperatures above 350°C and under varying atmospheres led to the *in-situ* formation of TiO₂ directly on the MXene surface. We prepared a series of electrodes using fluorine-doped tin oxide (FTO) glass as a substrate, with a layer of electrodeposited Cu₂O and MXene or TiO₂-MXene spray-coated on top. On the prepared photo-electrocatalysts, we conducted linear sweep voltammetry tests using a 150W Xe-lamp in a 0.5M K₂SO₄, 0.5M KHCO₃ electrolyte, saturated with argon or CO₂. Additionally, product analysis was performed under photo-electrocatalytic conditions after 2 hours of irradiation using gas chromatography with TCD and BID detectors. CO₂ conversion on the bare Cu₂O electrode produced ethanol. When Cu₂O was coated with pre-calcined Ti₃C₂T_x, product selectivity shifted toward CO, H₂, and CH₃COOH.

In this contribution, we will explore the relationship between the *in-situ* formed TiO₂ on Ti₃C₂T_x at various temperatures and atmospheres, and the overall catalytic performance of the photocathodes.



Scheme 1: Energy band structure of Cu₂O, TiO₂ and MXene, and redox potential of various CO₂ products formation.

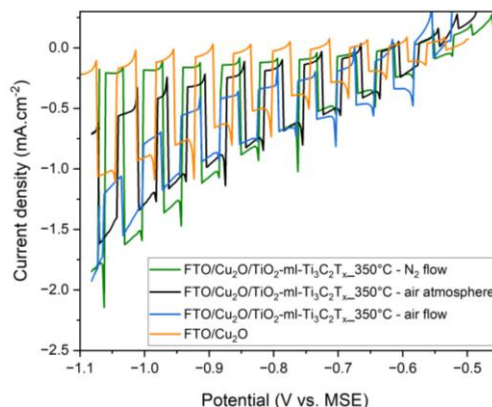


Figure 1: Linear sweep voltammetry of FTO/Cu₂O/TiO₂-MXenes in 0.5M K₂SO₄, 0.5M KHCO₃ saturated CO₂ under chop light irradiation.

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References:

¹ Low, J. et al. TiO₂/MXene Ti₃C₂ Composite with Excellent Photocatalytic CO₂ Reduction Activity. *Journal of Catalysis* 2018, 361, s55–266. DOI: [10.1016/j.jcat.2018.03.009](https://doi.org/10.1016/j.jcat.2018.03.009)