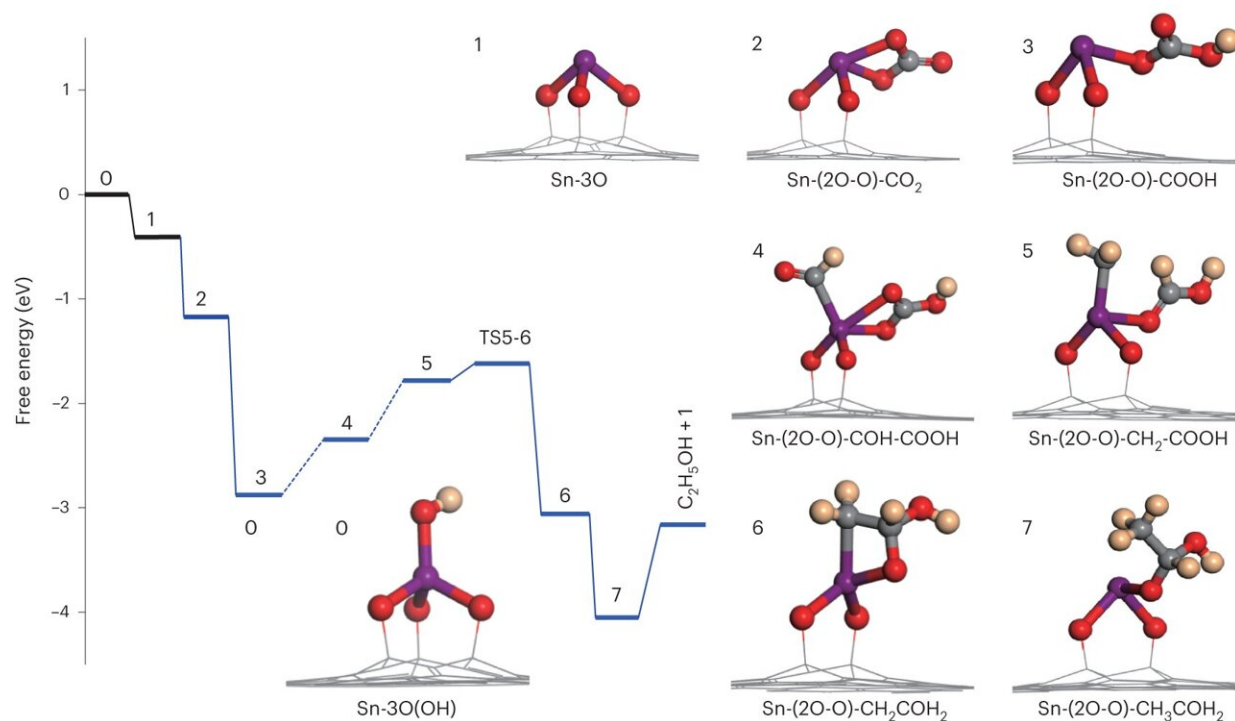


# Tandem single-atom electrocatalyst realizes reduction of CO<sub>2</sub> to ethanol

November 13 2023, by Li Yuan



C–C bond formation via a formyl-bicarbonate coupling pathway (with a key intermediate 4). Reaction energy profiles and the corresponding intermediate structures (0 to 7) for the formation of ethanol via the CO<sub>2</sub>RR on the Sn<sub>1</sub>-O<sub>3</sub>G catalyst. Credit: *Nature Energy* (2023). DOI: 10.1038/s41560-023-01389-3

The electrochemical CO<sub>2</sub> reduction reaction (CO<sub>2</sub>RR) into carbon-based fuels provides a promising strategy to mitigate CO<sub>2</sub> emission and

promotes the utilization of renewable energy.

The  $C_n$  ( $n \geq 2$ ) liquid products are desirable because of their high energy densities and ease of storage. However, manipulation of C–C coupling pathway remains a challenge due to the limited mechanistic understanding.

Recently, a research group led by Profs. Zhang Tao and Huang Yanqiang from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has developed a Sn-based tandem electrocatalyst ( $SnS_2@Sn_1-O_3G$ ), which could reproducibly yield ethanol with a Faradaic efficiency of up to 82.5% at  $-0.9 V_{RHE}$  and a geometric current density of  $17.8 \text{ mA/cm}^2$ .

The study was [published](#) in *Nature Energy* on Oct. 30.

The researchers fabricated the  $SnS_2@Sn_1-O_3G$  through solvothermal reaction of  $SnBr_2$  and thiourea on a three-dimensional carbon foam. The electrocatalyst comprised  $SnS_2$  nanosheets and atomically dispersed Sn atoms ( $Sn_1-O_3G$ ).

Mechanistic study showed that this  $Sn_1-O_3G$  could respectively adsorb  $*CHO$  and  $*CO(OH)$  intermediates, therefore promoting C–C bond formation through an unprecedented formyl-bicarbonate coupling pathway.

Moreover, by using isotopically labeled reactants, the researchers traced the [pathway](#) of C atoms in the final  $C_2$  product formed over the catalyst of  $Sn_1-O_3G$ . This analysis suggested that the methyl C in the product comes from [formic acid](#) whereas the methylene C was from  $CO_2$ .

"Our study provides an alternative platform for C–C bond formation for [ethanol](#) synthesis and offers a strategy for manipulating  $CO_2$  reduction

pathways towards desired products," said Prof. Huang.

**More information:** Jie Ding et al, A tin-based tandem electrocatalyst for CO<sub>2</sub> reduction to ethanol with 80% selectivity, *Nature Energy* (2023). [DOI: 10.1038/s41560-023-01389-3](https://doi.org/10.1038/s41560-023-01389-3)

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