Tandem single-atom electrocatalyst realizes reduction of CO2 to ethanol

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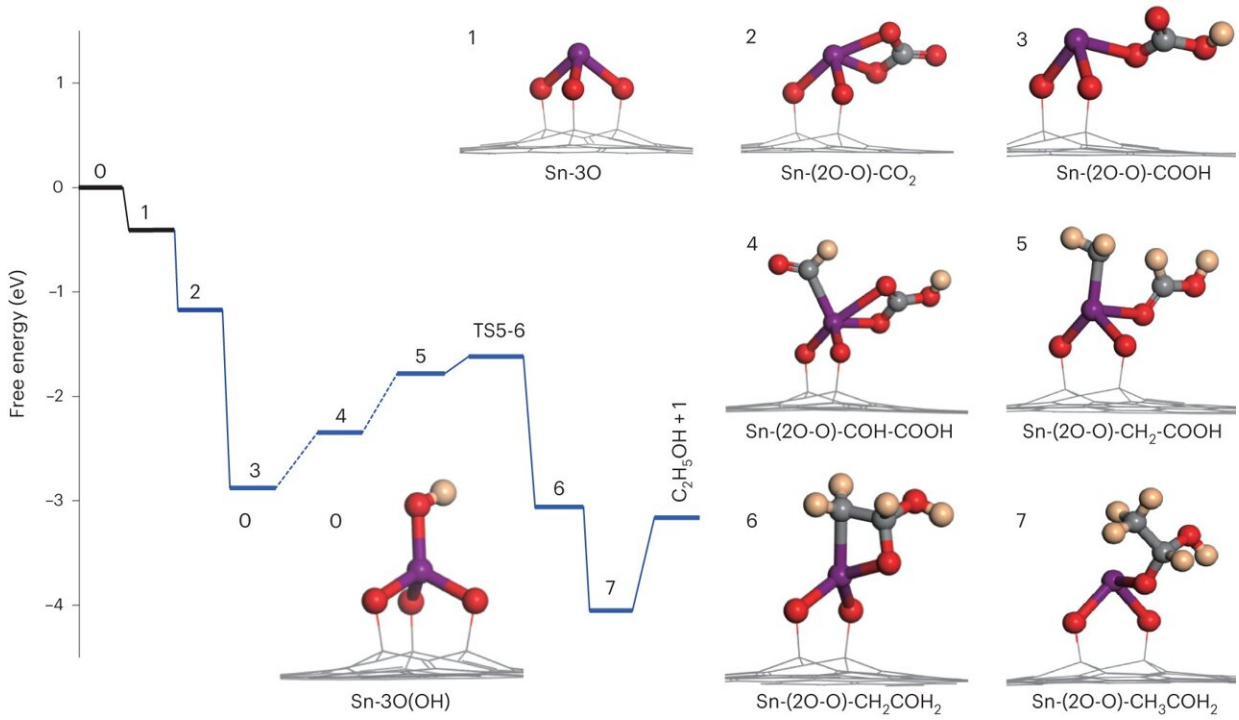

C–C bond formation via a formyl-bicarbonate coupling pathway (with a key intermediate 4). Reaction energy profiles and the corresponding intermediate structures (0 to 7) for the formation of ethanol via the CO_2RR on the Sn_1-O3G catalyst. Credit: *Nature Energy* (2023). DOI: 10.1038/s41560-023-01389-3

The electrochemical CO_2 reduction reaction (CO_2RR) into carbon-based fuels provides a promising strategy to mitigate CO_2 emission and

promotes the utilization of renewable energy.

The C_n (n≥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-O3G), 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 mA/cm^2.

The study was published in *Nature Energy* on Oct. 30.

The researchers fabricated the SnS_2@Sn_1-O3G 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-O3G).

Mechanistic study showed that this Sn_1-O3G 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-O3G. 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 CO2 reduction to ethanol with 80% selectivity, *Nature Energy* (2023). DOI: 10.1038/s41560-023-01389-3

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