

Dual-site catalysts featuring platinum-group-metal atoms on copper shapes boost hydrocarbon formations in electrocatalytic CO₂ reduction

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Copper-based catalyst is uniquely positioned to catalyze the hydrocarbon formations through electrochemical CO₂ reduction. The catalyst design freedom is limited for alloying copper with H-affinitive elements represented by platinum group metals because the latter would easily drive the hydrogen evolution reaction to override CO₂ reduction. We report an adept design of anchoring atomically dispersed platinum group metal species on both polycrystalline and shape-controlled Cu catalysts, which now promote targeted CO₂ reduction reaction while frustrating the undesired hydrogen evolution reaction. Notably, alloys with similar metal formulations but comprising small platinum or palladium clusters would fail this objective. With an appreciable amount of CO-Pd₁ moieties on copper surfaces, facile CO' hydrogenation to CHO' or CO-CHO' coupling is now viable as one of the main pathways on Cu(111) or Cu(100) to selectively produce CH₄ or C₂H₄ through Pd-Cu dual-site pathways. The work broadens copper alloying choices for CO₂ reduction in aqueous phases.

Among the catalytic reactions that can hydrogenate CO₂ into energy-intensive hydrocarbon molecules (HCs), the electrocatalytic CO₂ reduction reaction (CO₂RR) featuring CO₂ hydrogenation without producing H₂ gas in any prior steps is of particular interest. While there are ample choices of elements to catalyze CO₂RR into CO and formate molecules¹, copper (Cu) is the demonstrated element that can effectively catalyze the HCs formation (especially C₂-) owing to its optimal binding energies for both hydrogen (ΔE_{H^*}) and carbonyl species (ΔE_{CO})^{2–4}, the ubiquitous intermediate during CO₂RR. Copper, therefore, serves as a unique catalytic metal to not only enable the circular

carbon economy on earth but to extend human life beyond earth's orbit through in situ utilization of the in-space CO₂ to make methane as fuel or ethylene as building block molecules.

Metal alloying is a broadly employed strategy to accelerate the CO₂RR while reasonably suppressing the competitive hydrogen evolution reaction (HER)^{5–7}. Metals such as Ag, Au, Pb, and Sn that are either in the same group or to the right of Cu in the periodic table have been extensively studied⁸. These metals, with a typical positive H' binding energy (>0.5 eV), are the well-accepted desired alloying choices with copper due to their unfavorable energetics toward the

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Catalytic Formations: Bestsellers in 2023 The year 2023 has witnessed a noteworthy surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of bestselling books, exploring the captivating narratives that have enthralled audiences this year. The Must-Read : Colleen Hoovers "It Ends with Us" This touching tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover masterfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can succeed. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This spellbinding historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Catalytic Formations : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These popular novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and thrilling novel that will keep you speculating until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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