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Insights into the mechanism of electrocatalytic CO₂ reduction and concomitant catalyst degradation pathways

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Propositions

accompanying the thesis

Insights into the mechanism of electrocatalytic CO₂ reduction and concomitant catalyst degradation pathways

1. The reduction of carbon monoxide deserves much more attention from the scientific community than it currently enjoys: not only do there exist catalysts such as silver which can catalyze the formation of C₂+ products if it is present in sufficient quantities, the additional experimental control allowed by substituting carbon dioxide with carbon monoxide results in superior experiment design options (CH 2).
2. Obtaining one-step conversion of carbon dioxide to C₂+ products with good selectivity, activity and stability with heterogeneous electrocatalysts is a pipedream. Instead, we should place more emphasis on cascade-type systems (CH 2).
3. When gold is used as a catalyst for driving a fast reduction reaction in concentrated (non-buffered) electrolyte, the act of employing nanosized particles with intricate shape designs becomes entirely useless from a catalytic point of view (CH 3).
4. From the fact that we show copper to be more dimensionally stable than gold under reducing conditions, it logically follows that the concept of chemical nobility needs to be redefined (CH 3).
5. Copper characterization via cyclic voltammetry in sodium hydroxide electrolyte is an accurate technique for determining the interfacial facet distribution, but only when conducted properly with the results interpreted carefully (CH 4).

6. A two part preposition: geometric surface area is a useless metric for the normalization of catalytic activity in heterogeneous electrocatalysis and in all cases the electrochemically active surface area (EASA) should be determined and used instead. To follow up, double layer capacitance measurements as a means of determining EASA should only be used if no alternatives exist (CH 4).
7. Oxygen is the bane of any electrochemist working with copper, further exacerbated when employing alkaline electrolytes due to their propensity to retain oxygen (CH 5).
8. Metallic copper is stable under reducing conditions so long as oxygen is absent. However, the near impossibility of complying with this set of conditions makes this information irrelevant in the context of actual copper-driven catalysis (CH 5).
9. The current rate at which we are capable of generating data combined with the increased competitiveness of science as a whole has had a strong detrimental impact on the average quality of published works, with more time dedicated to producing volume and thereby leaving less time available for carefully scrutinizing both one's own and others' work.