

Extremely active and selective immobilized catalyst for electrocatalytic carbon dioxide reduction

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Well-defined metal complexes with chemical stability and structural tunability are a promising class of electrocatalytic CO₂ reduction (ECR) catalysts, especially immobilized metal phthalocyanines. However, the strong intermolecular π - π stacking interactions of non-substituted metal phthalocyanines usually result in overt aggregation, low solubility, and

thus generally un-controllable assembly on the support surface with uneven and multilayered deposition, severely reducing the accessible active sites.

Therefore, the development of the non-aggregated metal [phthalocyanine](#) catalysts with controllable assembly behaviors and tunable surface wettability for achieving excellent ECR performance is still a challenge.

In a study published in *Applied Catalysis B: Environmental*, a group led by Prof. Zhu Qilong from Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences reported an extremely active and selective immobilized pyrrolidinonyl nickel phthalocyanine (PyNiPc) catalyst for ECR.

This catalyst was constructed by a built-in pyrrolidone group-assisted assembly/fixation strategy, and presented single-molecular level dispersion of PyNiPc on carbon nanotubes to achieve the high surface density of Ni-N₄ active sites.

The researchers found that the resulting [catalyst](#) (PyNiPc/CNT) can predominantly produce CO in the electrocatalytic CO₂ reduction, affording nearly 100% Faradaic efficiency over a wide potential range and obtaining the ultrahigh CO/H₂ volume ratios up to 640 at -0.88 V vs. reversible hydrogen electrode (RHE).

Besides, they found that after continuous chronoamperometry test at the overpotential of 0.67 V for 10 h, the [current density](#) and Faradaic efficiency for CO were not significantly reduced.

Furthermore, the experimental results indicated that the high activity of PyNiPc/CNT for ECR originates from the single-molecularly Interfacial synergy-catalysis between PyNiPc and CNTs and the built-in pyrrolidone groups also play an important role in promoting

phthalocyanine dispersion and catalysis.

The study presents a new strategy to make the best of the excellent intrinsic activity of nickel phthalocyanine and provide valuable guides for the development of efficient and stable electrocatalysts for CO₂ reduction and other electrochemical techniques.

More information: Dong-Dong Ma et al. Remarkable electrocatalytic CO₂ reduction with ultrahigh CO/H₂ ratio over single-molecularly immobilized pyrrolidinonyl nickel phthalocyanine, *Applied Catalysis B: Environmental* (2019). [DOI: 10.1016/j.apcatb.2019.118530](https://doi.org/10.1016/j.apcatb.2019.118530)

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