Highly selective production of ethylene by electroreduction of carbon monoxide

With the support by the National Natural Science Foundation of China and the Ministry of Science and Technology of China, the research team led by Prof. Deng DeHui (邓德会) from the State Key Laboratory of Catalysis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, recently made important progress in highly selective electroreduction of CO to ethylene, which was published as a communication in *Angew Chem Int Ed* (2020, 59: 154) and was also highlighted as a Hot Paper by this journal.

Ethylene (C_2H_4) is an important building block for chemical industry and usually produced by steam cracking of naphtha feedstocks at 800-900oC worldwide. However, considering the utilization of the nonpetroleum carbon resources, converting CO from syngas (CO+H_2) to C_2H_4 is also regarded as one of the key processes. Fischer-Tropsch synthesis (FTS) is usually under high temperatures (200—450℃) and high pressures (5—50 bar), and the products from the FTS process are often limited by the Anderson-Schulz-Flory distribution. Therefore, the development of a highly selective and energy-saving ethylene production route without additional separation and waste of carbon resources is of great technological, economical and environmental interest.

A highly selective ethylene production process from electrocatalytic CO reduction with water at room temperature and ambient pressure was achieved through rational optimization of polytetrafluoroethylene content to increase CO concentration at the surface of electrodes and Cu particle catalysts to enhance the C—C bond coupling. This electrocatalytic CORTE process can achieve an unprecedentedly high ethylene FE of 52.7%. Moreover, the selectivity based on CO conversion to ethylene is around 70%, breaking through the 30% selectivity limitation from CO to C_2 hydrocarbons in the traditional FTS process, which always delivers uncontrollable mixtures of C_1—C_4 hydrocarbons and massive CO_2. Besides, cooperating with Prof. Hai-Yan Su and Prof. Dong H. Zhang, Deng's group studied the reaction active sites and mechanism by DFT calculations. Theoretical calculations suggest that Cu(100) is the most preferred plane for C_2H_4 formation via considering all possible products. This electrocatalytic CORTE process provides a highly selective, energy-efficient and eco-friendly way to convert the abundantly industrial CO to C_2H_4 in comparison with the FTS process.

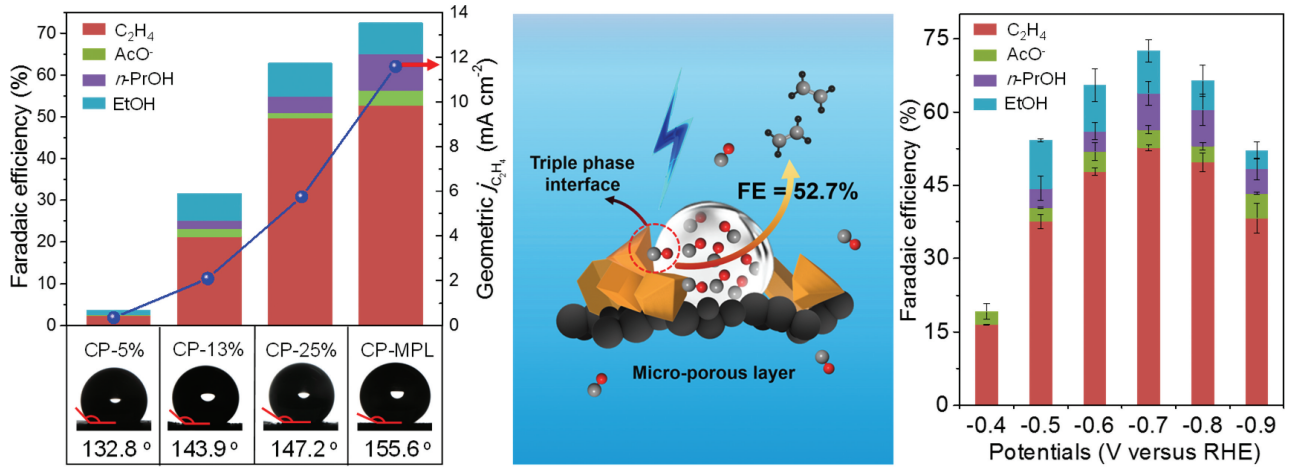

Figure Highly selective production of ethylene by electroreduction of carbon monoxide.