2020「中技社科技獎學金」

2020 CTCI Foundation Science and Technology Scholarship

研究獎學金

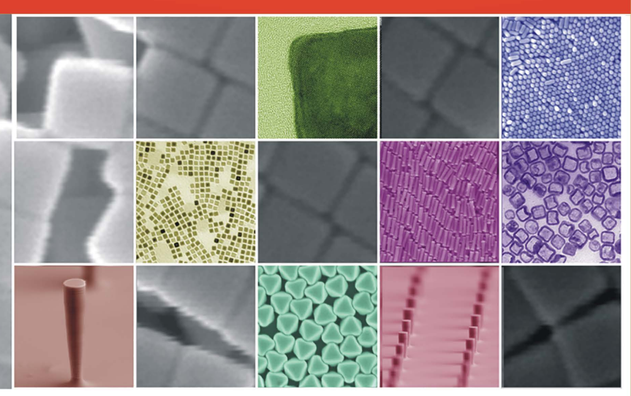
Research Scholarship

電催化二氧化碳還原之臨場與非臨場X光吸收及繞射光譜分析

Probing the reaction of electrochemical CO_2 reduction by using in-situ/ex-situ XAS and XRD analysis

國立台灣大學 化學系 博士班三年級 張家睿

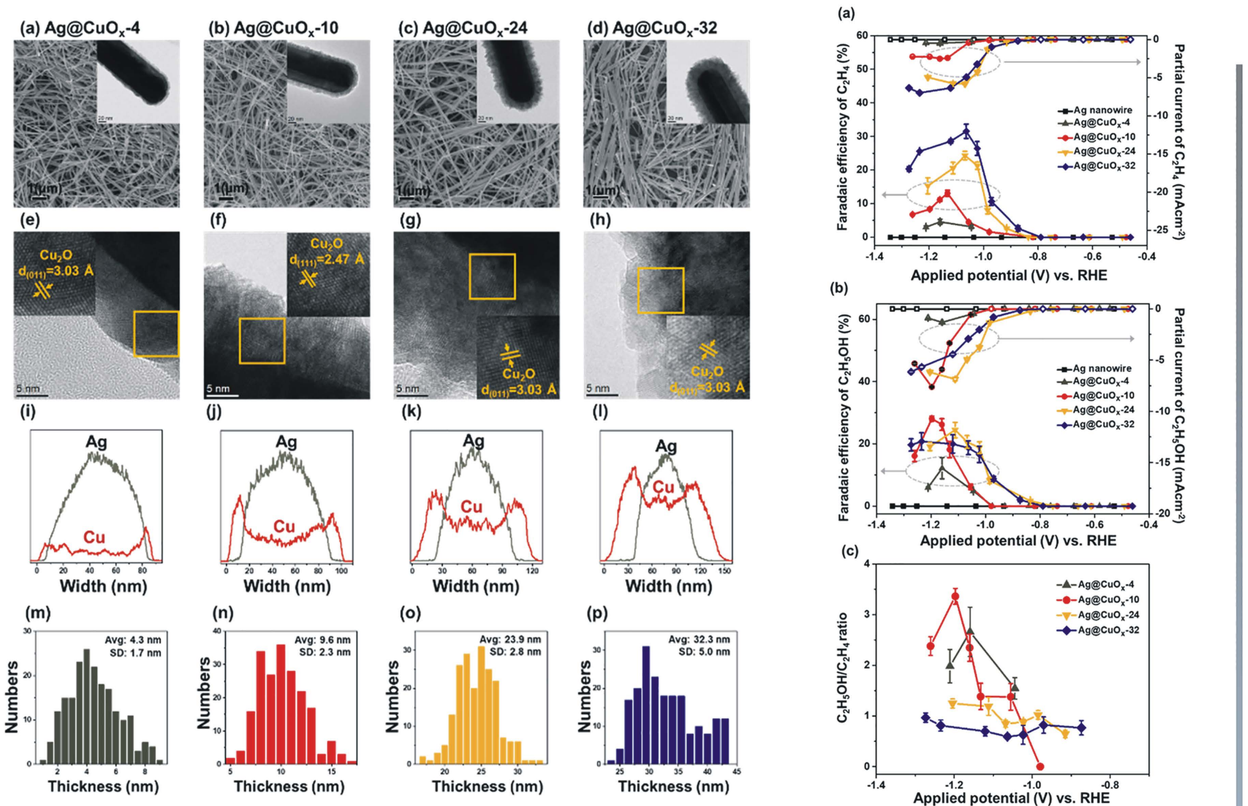
指導教授 陳浩銘 教授

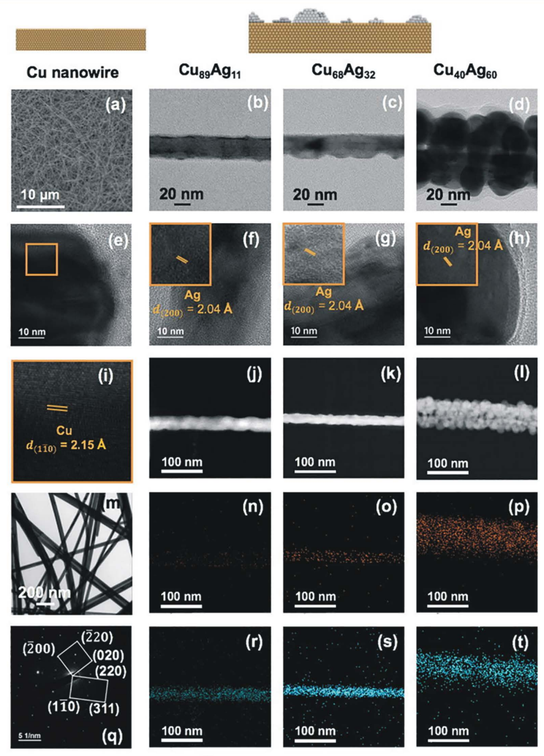


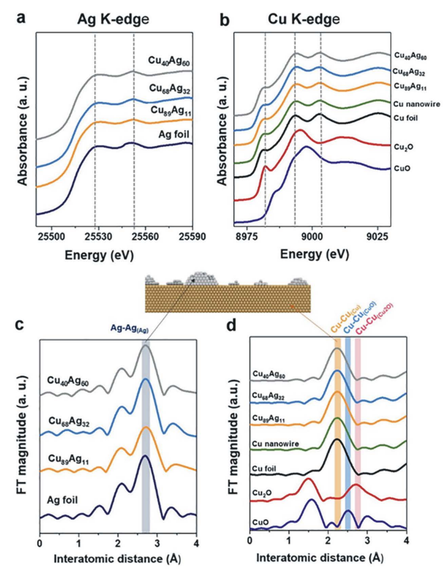
研究重點

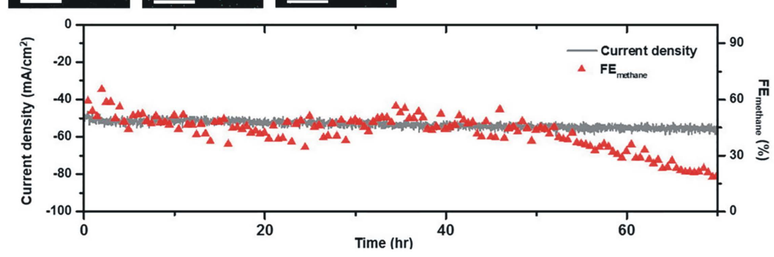
The rising anthropogenic CO_2 emissions originating from the combustion of fuels and the chemical industry has been recognized as the main factor for climate change. It is in urgent need to desperately develop a carbon-neutral approach to attain a sustainable society. Among the viable approaches, the electrochemical CO_2 reduction reaction (CO_2RR) has emerged as one of the promising conversion strategies for converting CO_2 into carbon-based products and thereby potentially closing the carbon cycle. To date, numerous design strategies have been deployed to enhance the activity as well as the selectivity. For example, creating grain boundaries, changing the surface morphology, surface modification, tuning the oxidation state and even introducing other elements can effectively improve the performance toward CO_2RR. Despite the huge progress on the activity and selectivity, still, the origin efficiency variations remain in dispute. To elucidate the enhanced activity of catalysts, most researches rely on theoretical calculations or ex situ characterization techniques. Nonetheless, regardless of successfully explaining the imperative activity through theoretical calculation, catalysts may undergo structural evolution under working conditions, and thus, it may be misleading since most researches only focus on the structure of catalysts before conducting the reaction processes. On the other hand, ex situ characterization on the pre- and postcatalysts of the reaction are frequently-adopted method to explicate catalytic behaviors. Yet, possible contamination may affect the results during the chamber-to-chamber transportation. It would therefore be desirable to investigate the structure of catalysts during the reaction. To this end, applying in situ techniques are imperative to identify the real active sites for unraveling true catalytic mechanisms. To ascertain a dynamic transformation during CO_2RR, we investigated the phase-separate bimetallic catalyst (Ag@CuO_x-X) by using in situ techniques. The results reveal that the stabilized valence state of Cu governs the selectivity toward CO_2RR products. In our another research, the bimetallic CuAg catalyst exhibits atomic interdiffusion process for facilitating CuAg alloy formation during CO_2RR, leading to high methane production. Based on our researches, it evidently reveal that in situ manners are imperative to establish the interplay between different atomic species in bimetallic catalysts and provide deeper insight for designing promising modulations for efficient CO_2RR electrocatalysts.

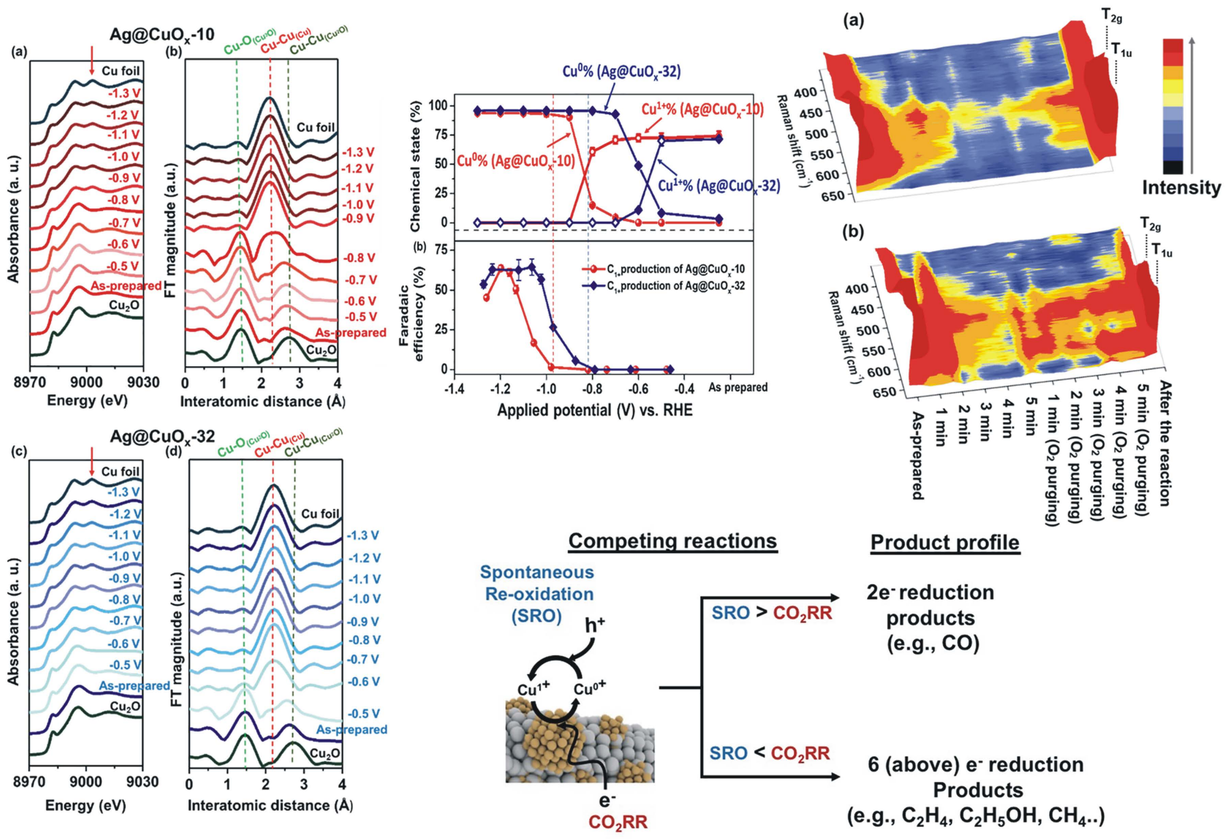
研究成果

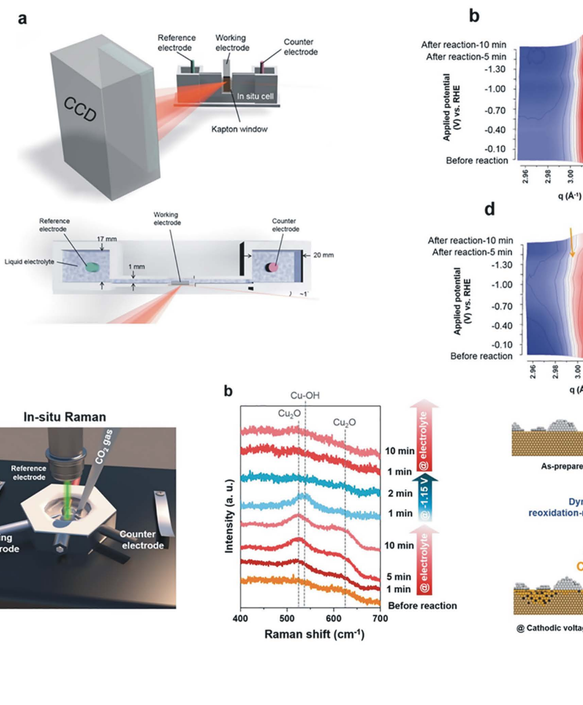


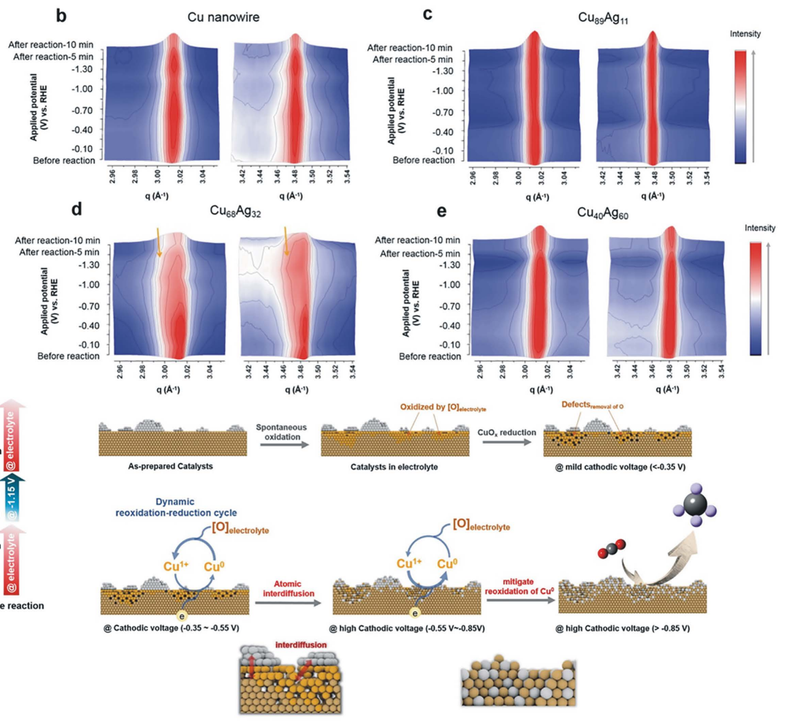












Chang, C.-J.; Hung, S.-F.; Hsu, C.-S.; Chen, H.-C.; Lin, S.-C.; Liao, Y.-F.; Chen, H. M., Quantitatively Unraveling the Redox Shuttle of Spontaneous Oxidation/Electroreduction of CuOx on Silver Nanowires Using in Situ X-ray Absorption Spectroscopy. *ACS Cent. Sci.* **2019,** *5* (12), 1998-2009.

Chang, C.-J.; Lin, S.-C.; Chen, H.-C.; Wang, J.; Zheng, K. J.; Zhu, Y.; Chen, H. M., Dynamic Reoxidation/Reduction-Driven Atomic Interdiffusion for Highly Selective CO_2 Reduction toward Methane. *J. Am. Chem. Soc.* **2020,** *142* (28), 12119-12132.

研究心得

到目前為止這三年的博士班生涯，最大的挑戰便是克服實驗困難以及數據上的闡述，很幸運的能夠有一些關於電催化二氧化碳還原的研究成果與大家分享，在這過程當中，我最想感謝的是我的指導教授陳浩銘老師，每當我遇到實驗題目上的問題，總是能夠適時的提出意見供我參考，也能精闢的洞察研究發現，讓我受益良多，除此之外也要謝謝我的實驗室同仁，與你們討論實驗數據以及文獻時，總是能夠有意想不到的收穫，沒有你們我也不可能做到這些成果，更重要的，是在背後默默支持我的家人，讓我不用擔心家裡的經濟狀況，能夠心無旁騖的專心學習，最後當然要謝謝中技社給予我的支持。我相信在剩下的博士班生涯，我能夠再對電催化反應的催化有更多的貢獻，充實自己的研究。