

## 張億宏 陳于琦 2025物理年會論文壁報發表獲獎

學習新視界

【舒宜萍淡水校園報導】2025全國物理年會暨國科會計畫成果發表會，1月14至16日在國立中山大學逸仙館舉行，本校物理系助理教授王孝祖指導尖端材料科學學程四張億宏，與物理系助理教授吳俊毅指導物理四陳于琦，分別以壁報論文發表研究成果，在眾多國立大學大學部、碩士班、博士班學生及博士後研究員中表現優異，雙雙榮獲論文壁報佳作獎，為所有獎項中唯二的私校獲獎學生。

張億宏為尖端材料與光譜實驗室專題生，發表論文為《The evolution of local electronic and atomic structures on self-assembly nanoparticle CoO/MXene composite for water splitting catalysis，奈米自組裝CoO/MXene在水分解催化的局部電子和原子結構分析》，獲新興能源科學組壁報發表佳作。張億宏利用水熱法，合成出具有雙功能性之奈米複合材料，用電化學方法探究不同比例樣品的電化學性能。

張億宏感謝王孝祖，給予同步輻射相關技術和研究方向上的建議與指導，更提供良好的實驗室資源，讓他了解到同儕間互助合作的重要性。而物理系的課程規劃，讓自己更能專注在專題上面，未來會持續朝這方面進行更深入的研究，希望將此專題發表在國際期刊上，有利於以MXene做為催化反應的研究群，致力於研發更高效能的水分解催化材料。

陳于琦發表論文為《Necessary multiphoton indistinguishability for entanglement in Boson sampling systems》，獲量子資訊與量子計算組壁報發表佳作。她與團隊構建了一個線性光學網路系統模型，結合現有的糾纏驗證方法進行分析。研究結果顯示，當光子的輸入狀態位於布洛赫球面上（即為純態）並呈現可區分性時，其保真度的總和皆超過可分離態的理論上限，這進一步證實了系統之間存在量子糾纏。

陳于琦感謝吳俊毅，以淺顯易懂的方式解釋複雜理論，並適時結合數學推導，讓自己對研究內容有更清晰的理解，尤其十分注重細節，全面考量量子光學中，可能影響量子糾纏生成與檢測的各種因素，耐心地與學生探討數據分析的合理性。已考上清華大學光電工程所碩士班的她，希望進一步提升自己在量子光學實驗與模擬方面的技能，為量子科技發展貢獻心力。



# The evolution of local electronic and atomic structures on self-assembly nanoparticle CoO/MXene composite for watersplitting catalysis

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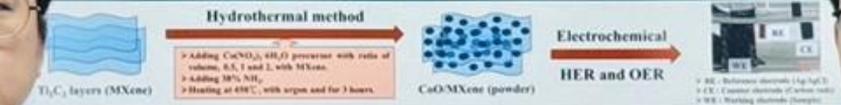
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## Abstract

Hydrogen is clean and efficient energy. However, sluggish kinetic for both Hydrogen evolution reaction (HER) and Oxygen evolution reaction (OER) should be overcome.  $Ti_3C_2Tx$  (MXene) with a 2-dimensional channel serves as conductive supporting material can improve the poor conductivity of CoO nanoparticles for bifunction. To control these performance, we synthesized CoO/MXene with different specific ratios of volume, 0.5, 1 and 2. CoO/MXene-1 performs the well bifunction indicated by electrochemical measurement. In the further investigation of local electronic and atomic structure shown by Ti K-edge and Co K-edge X-ray Absorption Spectroscopy (XAS), Co in CoO/MXene-1 has the least unoccupied state of 4p orbital and Ti in CoO/MXene-1 has the most unoccupied state of 4p orbital indicated these electrons transfer the most obviously from Co to Ti in CoO. On the other hands, we initially use Raman spectra to confirm the existence of functional group on CoO/MXene. Then, the Cu L<sub>2,3</sub>-edge, Ti L<sub>2,3</sub>-edge and O K-edge soft XAS are used to investigate the unoccupied state of 3d orbital in metal and 2p orbital of metalloid and 2p-3d hybridization between metal and metalloid. The results show that the presence of functional group to the metal in CoO/MXene. According to these results, CoO/MXene-1 has the most unoccupied state in metal and oxygen but the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound. The results also indicate the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound. The results also indicate the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound. The results also indicate the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound.

## Experiment



## Electrochemical measurement

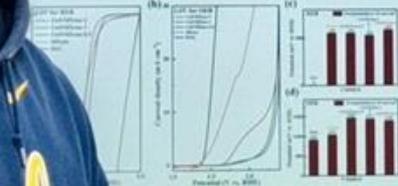


Figure 1. (a) Cyclic voltammograms (CVs) and (b) linear sweep voltammograms (LSVs) for HER and OER. (c) Tafel plots for HER and OER. (d) Bar charts showing the overpotential for HER and OER for CoO/MXene-1, CoO/MXene-2, and CoO/MXene-3.

## Characterization

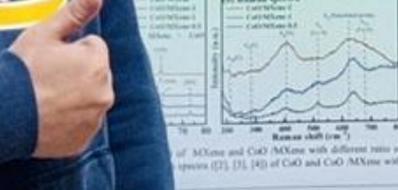


Figure 2. (a) Raman spectra and (b) XRD patterns for CoO/MXene-1, CoO/MXene-2, and CoO/MXene-3.

## X-ray Absorption Spectroscopy

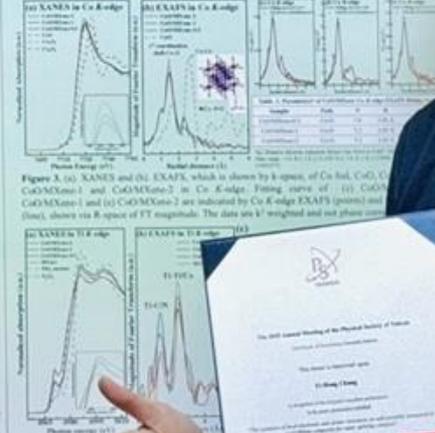
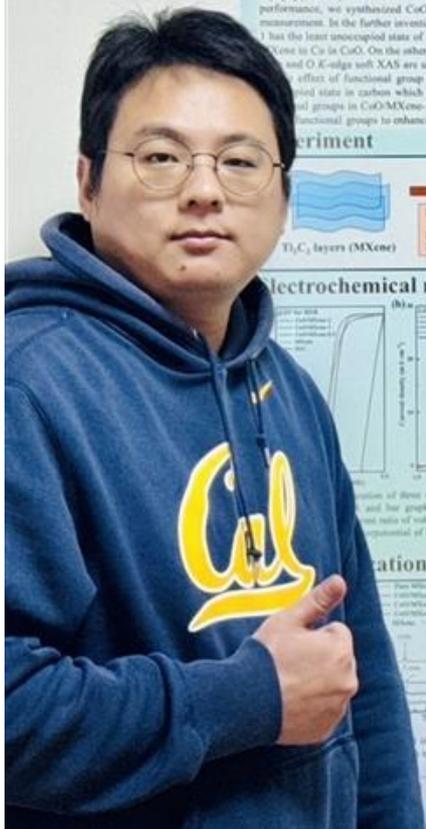


Figure 3. (a) XANES and (b) EXAFS, which is shown by k-space, of Co K-edge, CoO, CoO/MXene-1 and CoO/MXene-2 in Co K-edge. Fitting curve of (a) CoO/MXene-1 and (b) CoO/MXene-2 are indicated by Co K-edge EXAFS (green) and (blue), shown via k-space of FT magnitude. The data are k<sup>3</sup> weighted and are phase corrected.

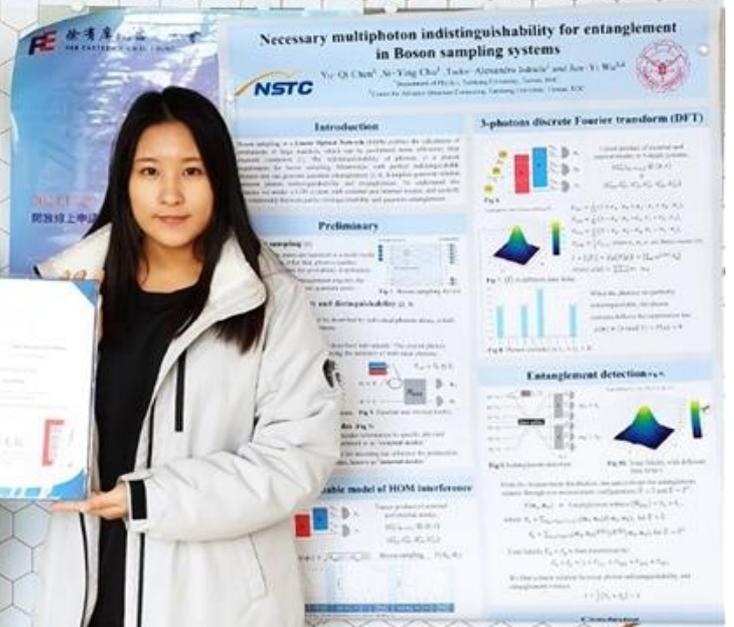
## Conclusion

The results show that the presence of functional group to the metal in CoO/MXene. According to these results, CoO/MXene-1 has the most unoccupied state in metal and oxygen but the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound. The results also indicate the most occupied state in carbon which may not only indicates these electrons transfer the most obviously from metal and oxygen predominated in CoO to carbon compound.



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