

李奇峰獲國輻中心年會壁報佳作 展現材料科學研究實力

學習新視界

【本報訊】國家同步輻射研究中心（NSRRC）9月2至4日舉辦第31屆用戶年會暨研討會，此為國內同步輻射研究領域規模盛大且深具指標性之學術會議，吸引眾多學者與研究人員共襄盛舉，本校物理系碩一李奇峰，參與壁報競賽獲得佳作，是材料科學組唯二的私校獲獎者。

李奇峰發表題目為「Deciphering PtNi Nanoparticles Formation: In-Situ X-ray Spectroscopy Insights into Microstructural Evolution」（PtNi奈米粒子形成機制之剖析：原位X光光譜對微觀結構的演化與洞察），探討奈米雙金屬顆粒（PtNi-NP）於氫氣生成反應（HER）中的結構變化。透過臨場X光吸收光譜（XAS）、X光繞射（XRD），以及掃描式X光顯微術（STXM），解析材料在加熱過程中的微觀變化，發現鉑轉為金屬態，並逐步形成PtNi-NP的結構，顯示出明顯的相變行為，揭示催化劑形成過程中的結構重整機制。

曾隨團隊前往臺灣的NSRRC、日本SPring-8與UVSOR等國際設施進行研究，累積不少經驗的李奇峰，特別感謝指導教授，物理系助理教授王孝祖在研究與技術訓練上的耐心指導，讓他對先進材料、光譜分析技術，以及前沿同步輻射研究等方面皆獲得實質成長。更強調在王孝祖「尖端材料與光譜實驗室」的訓練下，不僅提升了研究能力與獨立思考，更培養了面對挑戰時的冷靜與解決問題的能力。

王孝祖肯定李奇峰的表現，表示其自大二下加入實驗室以來，始終保持積極進取的態度，特別是對同步輻射相關技術展現高度熱忱，在實驗過程中細心嚴謹，是極具潛力的研究人才，期待他未來能在學術發展上持續突破，呈現更卓越的成果。

Deciphering PtNi Nanoparticles Formation : *In-situ* X-ray spectroscopy Insights into Microstructural Evolution



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Abstract

The construction of Pt-based bimetallic alloy nanoparticles with Pt-enriched shells exhibits remarkable performance advantages in the hydrogen oxidation reaction (HOR), making them a hot topic in electrocatalysis. The experimental results at a current density of 10 mA/cm² at 0.1 V/RHE demonstrating excellent catalytic performance. The remaining performance ratios PtNi-100 (highly Pt surface) roughly 10-fold compared the changes in both structure and phase composition during the evolution of PtNi bimetallic nanoparticles (PtNi-100), the research utilizes *in-situ* X-ray diffraction (XRD) and *in-situ* X-ray absorption fine structure (XAFS) to investigate the evolution of PtNi bimetallic nanoparticles (PtNi-100) under heating at 400 °C. The diffraction peak of Pt(111) shifts to a higher angle and becomes sharper, indicating changes in the lattice constant due to the reduction in lattice spacing during heating. *In-situ* XAFS successfully revealed the atomic coordination changes from PtNi structure to PtNi-100. The data show that the nearest shell Pt atoms move from 0.24 nm to 0.22 nm as the temperature increases, with a significant Pt enrichment in the outer region, and the coordination number of Pt atoms increases, indicating that a certain number of Pt atoms move through the process. Interestingly, EXAFS revealed that Pt exhibits different behavior within the same region, and the coordination number of Pt atoms increases as the temperature increases. EXAFS measurements also revealed an increase in Pt coordination number with increasing temperature. The *in-situ* XRD and XAFS data show that the PtNi-100 nanoparticles undergo a significant change from PtNi-100 (Pt:PtNi = 1:1) to PtNi-100 (Pt:PtNi = 2:1). The XRD results further indicate that during the heating process, the microstructure of PtNi-100 evolves, which occurs around 400 °C, after which PtNi-100 nanoparticles disappear. EXAFS data show *in-situ* XAFS further revealed that as the temperature rises, Pt enrichment from a Pt-100 to a bimetallic state, consistent with the XRD and EXAFS results. These findings demonstrate that *in-situ* X-ray spectroscopy provides clear and accurate evidence of large observed microstructural evolution of PtNi-100 and highlights the superior catalytic activities of PtNi-100 in HOR applications.

In-situ Experiment & Results

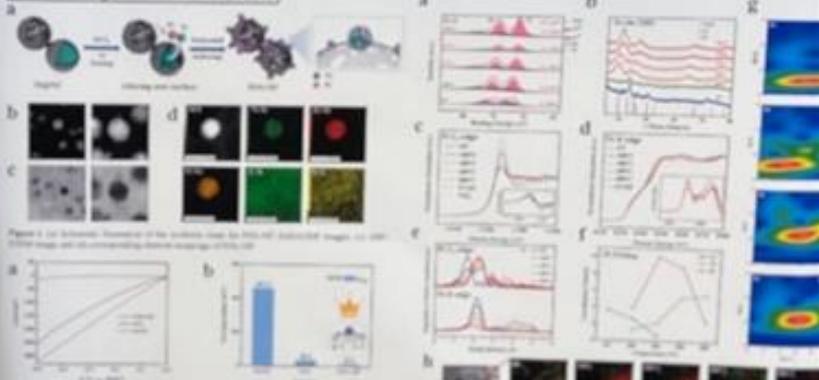


Figure 1. (a) Schematic illustration of the synthesis route for PtNi-100 (Pt:PtNi = 1:1) at 400 °C. (b) XRD patterns of PtNi-100 nanoparticles at different temperatures. (c) XAFS spectra of Pt L3-edge. (d) EXAFS spectra of Pt L3-edge. (e) EXAFS spectra of Ni K-edge. (f) EXAFS spectra of Pt K-edge. (g) HRTEM images of PtNi-100 nanoparticles.

Conclusions

Highly active PtNi-100 nanoparticles with Pt-enriched shells and PtNi-100 microstructure evolution during the heating process. These results indicate that the catalytic activity of PtNi-100 can significantly improve through *in-situ* X-ray spectroscopy. At 400 °C, the microstructure evolves with the formation of PtNi-100 and PtNi-100 nanoparticles. The XRD and XAFS data show that the PtNi-100 nanoparticles undergo a significant change from PtNi-100 (Pt:PtNi = 1:1) to PtNi-100 (Pt:PtNi = 2:1) during the heating process. The XRD results further indicate that during the heating process, the microstructure of PtNi-100 evolves, which occurs around 400 °C, after which PtNi-100 nanoparticles disappear. EXAFS data show *in-situ* XAFS further revealed that as the temperature rises, Pt enrichment from a Pt-100 to a bimetallic state, consistent with the XRD and EXAFS results. These findings demonstrate that *in-situ* X-ray spectroscopy provides clear and accurate evidence of large observed microstructural evolution of PtNi-100 and highlights the superior catalytic activities of PtNi-100 in HOR applications.



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