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TEM and EDX Studies on the Structural and Compositional Evolution of $PtNi_3$ Concave Nanocubes

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It has been demonstrated that the optical, biological, and chemical properties of metal nanoparticles are highly influenced by size, composition and morphology [1]. These systems are promising candidates for a wide variety of applications in catalysis, sensing, electronics, photonics, and medicine. Pt and its alloys have been receiving a great deal of attention because of their unique catalytic properties and a wide variety of economically driven applications. Recent work on Pt_3Co nanocubes [2] and Pt_3Ni nanoframes [3] showed enhanced catalytic activity with a strong dependence on the structure and composition of the nanocrystals.
In this work we utilize high-resolution transmission electron microscopy (HRTEM) and electron dispersive X-ray (EDX) spectroscopy to study the structural and compositional evolution of $PtNi_3$ concave nanocubes before and after annealing in order to understand the difference in their electrochemical properties. High-resolution TEM images of as prepared $PtNi_3$ concave nanotubes were observed along three representatives zone axes [001], [110], and [111], and showed that the initial $PtNi_3$ concave nanocubes are fcc nanocrystals(Fig.1 a-c), while after annealing most $PtNi_3$ concave nanocubes become hollow nanocrystals(Fig.1 d-f). EDX elemental mapping results showed that in as prepared nanocubes, Pt forms a cubic frame and the Ni EDX map indicates that it forms a sphere located inside and outside of the Pt cubic frame (Fig.2 a-c). After annealing, it was found that Pt-rich frame still exists but Ni EDX map shows much less Ni than initial nanocubes, and the Pt/Ni ratio after annealing is much higher than in initial nanocubes (Fig.2 d-f). We conclude that the $PtNi_3$ concave nanocubes developed from Ni-rich nanocrystals to Pt-rich nanoframes after annealing. The detail of the structure and composition evolution of $PtNi_3$ nanocubes before and after annealing will be discussed.

References

[1] Y. Xia, Y. Xiong, B. Lim, S. E. Skrabalak, Angew. Chem. Int. Ed.2009, 48, 60–103.
[2] Chenyu Wang, Cuikun Lin, Lihua Zhang, Zewei Quan, Kai Sun, Bo Zhao, Feng Wang, Nathan Porter, Yuxuan Wang, and Jiye Fang. Chemistry a European Journal. 2014, 20 (6), 1753-1759.
[3] C. Chen, Y. Kang, Z. Huo, Z. Zhu, W. Huang, H. Xin, J. D. Snyder, D. Li, J. A. Herron, M. Mavrikakis, M. Chi, K. L. More, Y. Li, N. M. Markovic, G. A. Somorjai, P. Yang, V. R. Stamenkovic, Science, 2014, 343,1319.
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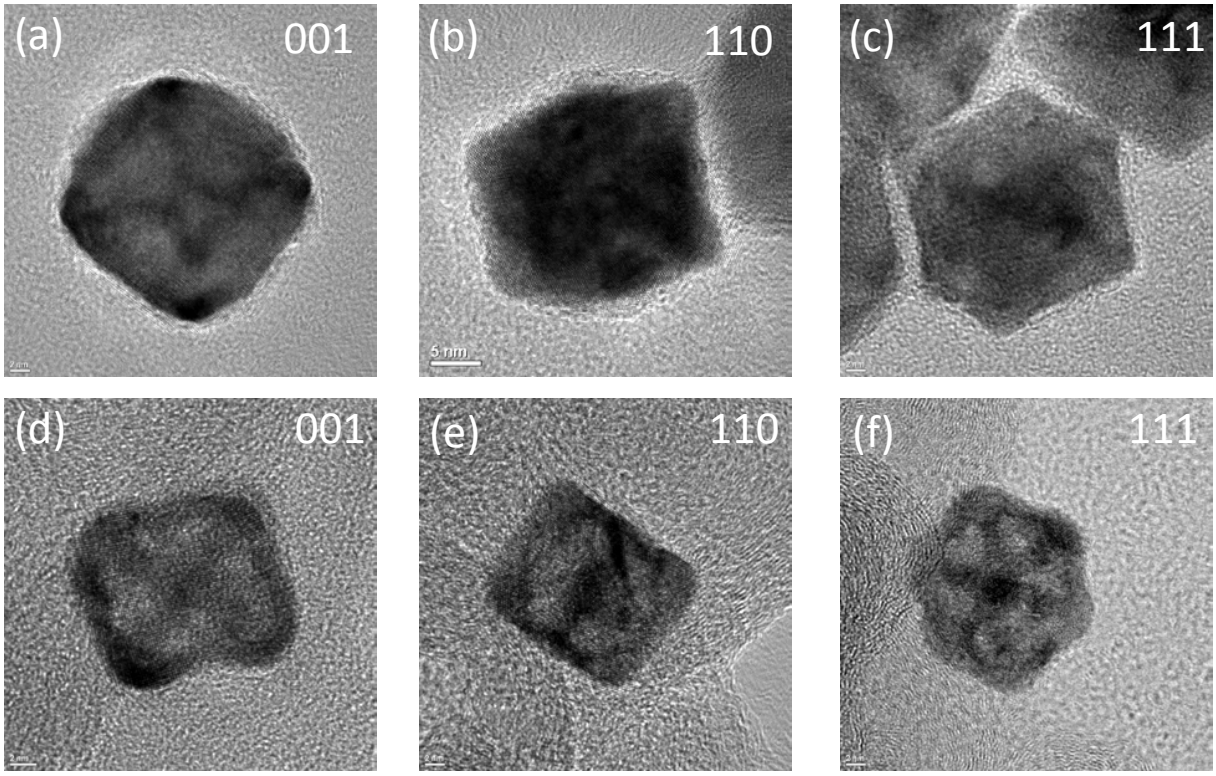

Figure.1 Bright field images from as prepared concave nanocubes (a)-(c), and from annealed nanocubes (d)-(f) along orientation [001], [110], and [111] respectively.

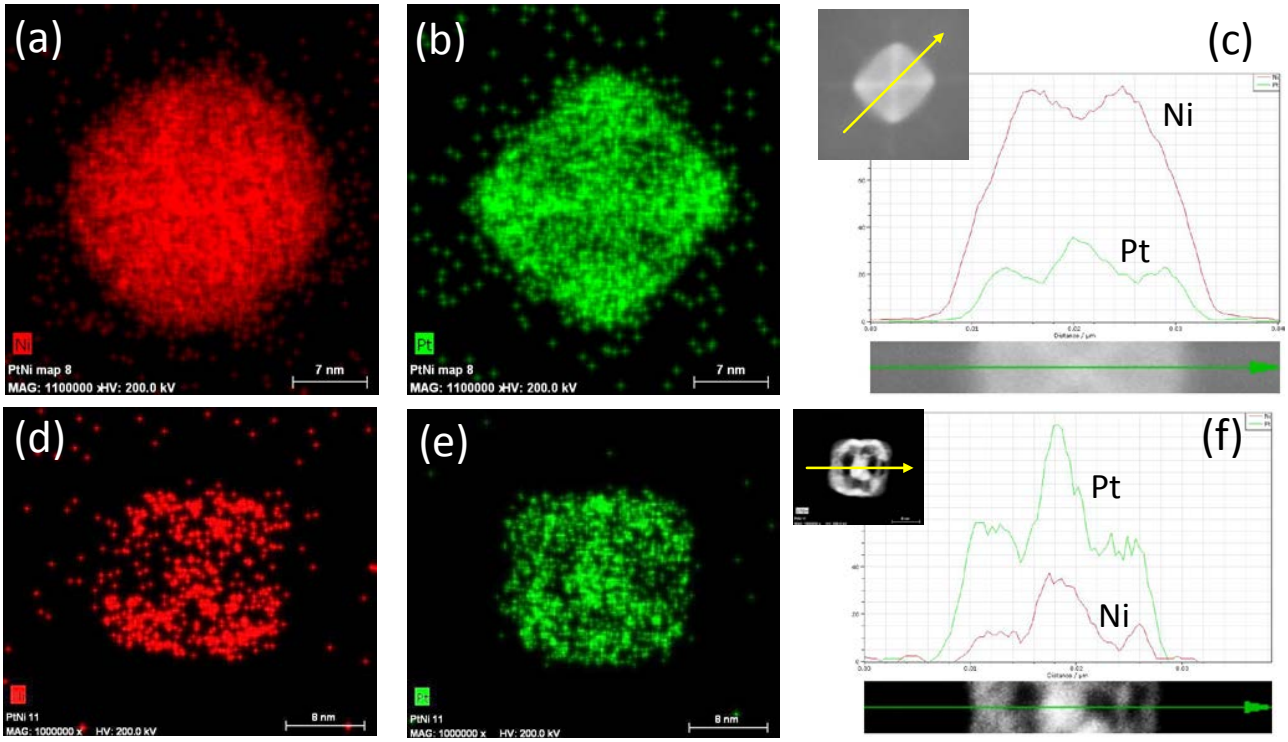

Figure.2 Elemental mapping and linescan of Ni and Pt from as prepared concave nanocube (a)-(c) and from annealed nanocube (d)-(f).