



Hawai'i Natural Energy Institute Research Highlights

Electrochemical Power Systems

Transition Metal Carbide Catalysts for Electrochemical Applications

OBJECTIVE AND SIGNIFICANCE: The objective of this project is to develop transition metal carbide catalysts for electrochemical applications. These carbide catalysts have the potential to improve the performance of a variety of electrochemical devices including fuel cells, water electrolyzers, and vanadium redox flow batteries.

BACKGROUND: The commercial application of a number of electrochemical technologies would benefit from the availability of low cost, efficient, and durable catalysts. Pt-group-metal catalysts are used in most commercially available fuel cells and water electrolyzers. Unfortunately, they have the shortcomings of high cost, low earth abundance, and limited lifetime. Transition metal carbides are attractive candidates because they possess an electronic structure similar to Pt, which promotes high activities, good electrical conductivity, low cost, high abundance, and outstanding thermal and chemical stabilities. However, carbide synthesis is a challenge for achieving high surface area particles due to the inevitable aggregation during the high-temperature carburization.

PROJECT STATUS/RESULTS: This work is exploring a simple and environmentally friendly synthesis process for carbides that involve in-situ carburization of a metal precursor and a carbon material. $V_8C_7/XC72$ and $V_6C_5/XC72$ were synthesized by adjusting the synthesis process (Figure 1a). It should be mentioned that the $V_8C_7/XC72$ here was obtained at lower temperatures compared with previous work. There is no evidence of the presence of any vanadium oxide in both $V_8C_7/XC72$ and $V_6C_5/XC72$. Molybdenum carbide was also synthesized. As shown in Figure 1b, no crystal structure changes after acid leaching in 3 M H_2SO_4 at $80^\circ C$, indicating that Mo_2C is acid resistant.

The literature reveals that the molybdenum carbide is very reactive toward sulfur-containing molecules oxidation. Preliminary results showed that carbon black supported vanadium carbides exhibited good electrocatalytic activity toward the electrochemical oxidation of aqueous SO_2 , which would be promising SO_2 -active catalysts.

Future studies will include validation of the electrochemical oxidation of aqueous SO_2 at these

catalysts by ex-situ cyclic voltammetry in acidic medium, integration of the contaminant-active catalyst in MEA using the ultrasonic spray coater at HNEI, and evaluation the contaminant tolerance of a PEM fuel cell to SO_2 with an in-situ catalytic conversion layer to demonstrate its practical application.

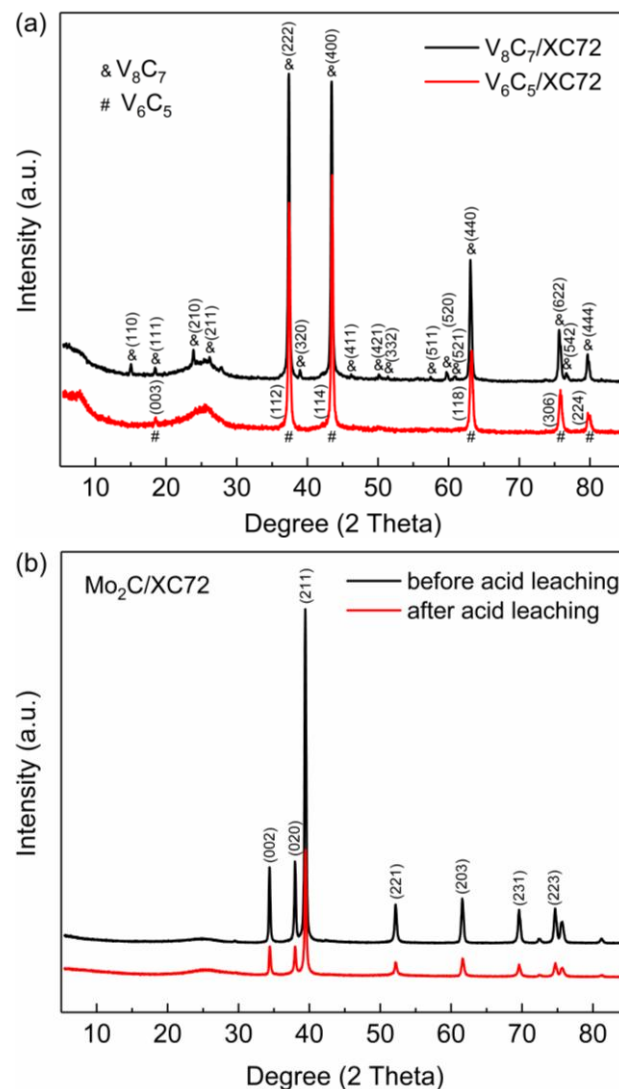


Figure 1. XRD patterns of (a) vanadium and (b) molybdenum carbides.

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