

Ni-Sr₂Fe_{1.5}Mo_{0.5}O_{6-δ} as Anode Materials for Solid Oxide Fuel Cells

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Ceramic anode materials have drawn a lot of attention due to their potentially better stability in different fuels or under redox cycling in Solid oxide fuel cells (SOFCs) comparing with conventional Ni-based cermet. Among the proposed ceramic anode candidates, perovskite-type oxides, such as LaCrO₃-based and SrTiO₃-based materials, have been intensively studied due to their relatively high mixed conductivity and good stability in reducing atmospheres. Recently, a new class Sr₂M_{1-x}Mo_xO_{6-δ} (M=Mn, Fe, Co, Ni, 0<x<1) with double perovskite structure have been demonstrated as anode materials for SOFCs (1). This type of materials has various B-site cation choices in a wide range of composition, which gives flexibility in tuning their properties. Several interesting anode candidates with this structure have been proposed with good stability in different fuels and under redox cycling (2, 3).

Ceramic anode materials exhibit good stability but there is still a lot of room for improving their overall cell performance. One of the limiting properties of these ceramic candidates is their relatively low catalytic activity. Many studies have shown that the fuel cell performance can be dramatically improved by introducing a small amount of metal catalysts to these mixed conductors. Unlike the cermet materials which requires large volume ratio of metal phase to provide percolating conductive passage for electrons, it is possible to fabricate highly dispersed metal catalyst on the mixed-conducting ceramic backbones. And with good mixed conducting properties, the ceramic materials may help to stabilize the catalyst phase, promote their catalytic activity and eventually mitigate the instability issues that cermet anodes have. Several examples have demonstrated both enhanced activity and stability of the metal modified ceramic anode materials (4-8).

Regarding to the modification method, infiltration is always an easy and effective way to obtain the supported catalysts on porous substrates and many reported metal modified ceramic anodes were prepared by this way. Recently, *in situ* reduction of metal particles from oxides has been considered as an alternative way to obtain the supported catalysts in certain material systems. Compared with infiltration method, this method doesn't need extra treatment step and is less affected by other factors, such as the morphology of ceramic backbones. Metal particle size and loading amount naturally are determined by the chemical properties of the oxides and theoretically the loading may be more homogeneous since the metals are precipitated directly from the lattice. Nano-sized Ni, Ru, and Pd particles were reported to be well dispersed on oxides via reduction of LaCrO₃-based materials or NbTi_{0.5}Ni_{0.5}O₄ and evidently improved fuel cell performance was observed with these composite anode materials (9-12). By reducing a cathode composition Pr_{0.4}Sr_{0.6}Co_{0.2}Fe_{0.7}Nb_{0.1}O_{3-δ}, nano-sized Co-Fe alloy particles supported on ceramic substrate were obtained. Besides the enhanced activity of the electrode, an

interesting regenerative behavior upon *in situ* redox cycling was also reported in this system (13).

Previously, we successfully improved Sr₂Fe_{1.5}Mo_{0.5}O_{6-δ} anode performance by infiltrating a small amount of Ni. Since Ni shows good catalytic activity and much easier to be reduced than Fe, here we substitute 10% Ni for Fe on B-site of Sr₂Fe_{1.5}Mo_{0.5}O_{6-δ} and expected to obtain a metal catalyst modified ceramic anode *in situ*. By introducing slight A-site deficiency, we successfully intrigued the metal precipitation in reducing atmospheres. The electrochemical performance and stability of the obtained composite anode were studied in this work.

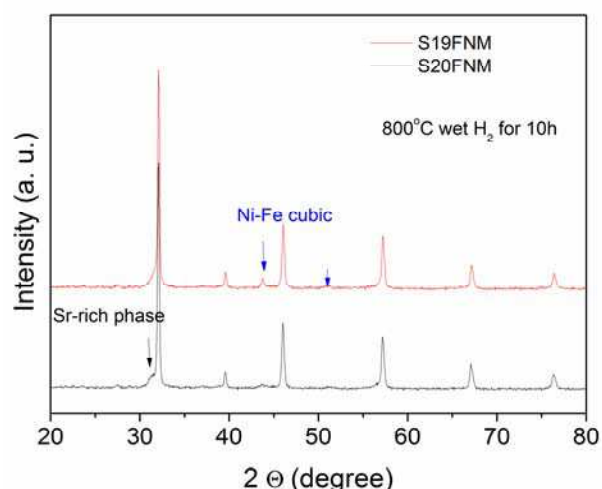


Figure 1. XRD pattern of Sr₂Fe_{1.4}Ni_{0.1}Mo_{0.5}O₆ (S20FNM) and Sr_{1.9}Fe_{1.4}Ni_{0.1}Mo_{0.5}O₆ (S19FNM) after reduction at 800°C in wet H₂ for 10h.

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