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## High-performance Multimetallic Spinel for Oxygen Evolution Reaction Catalysis



Hydrogen Energy & NanoMaterial Lab

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### Abstract

The development of efficient and affordable electrocatalysts for the oxygen evolution reaction (OER) is pivotal for the advancement of water electrolyzer technologies and the production of sustainable hydrogen fuel. This study investigates the application of multi-metallic oxides, or high entropy ceramics, as catalysts. The distinctive characteristics of these materials, such as lattice distortion and high configurational entropy make them valuable for use as catalysts. In this study, through the application of the sol-gel autocombustion method, electrocatalytic performance related to series of synthesized multi-metallic and monometallic oxides for OER within an alkaline medium was analyzed. The electrochemical analysis revealed that the synthesized five metallic spinels (5MS) yielded lowest charge transfer resistance and a tafel slope (33 mV.dec<sup>-1</sup>), outcomes attributed to factors such as space charge-interfacial and hopping polarization, moderated covalency of metal–oxygen (M–O) bonds and low distance between active sites. Collectively, these factors contribute to M–O bond breakage and consequent formation of active sites with faster rate.

### Results

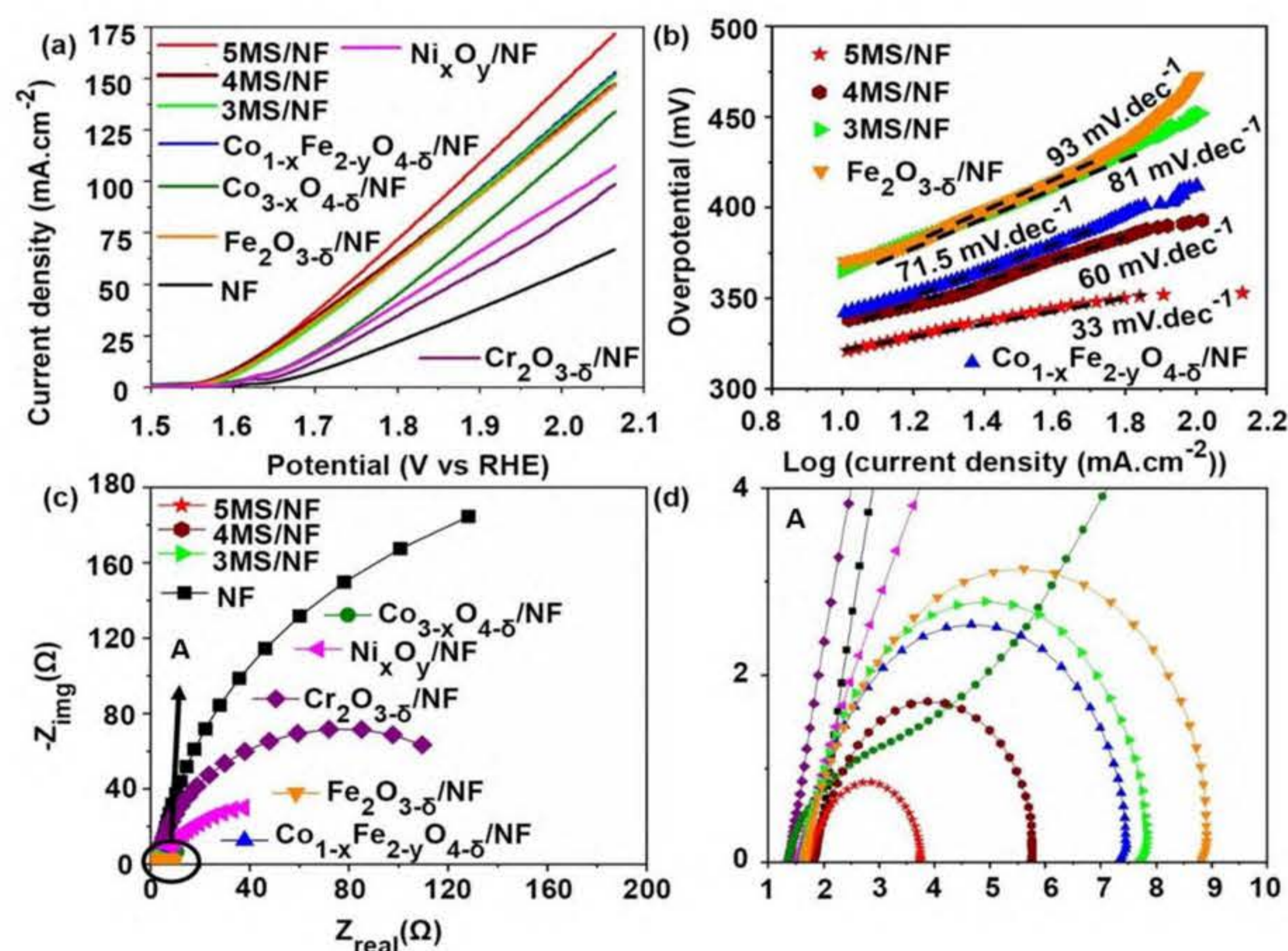


Figure 1 Electroanalytical test inside 1 M KOH (a) uncompensated polarization curve (b) Tafel slope calculated from 100% iR<sub>s</sub> compensated LSV (c) Nyquist plot recorded at 1.566 V (vs RHE) and magnified region A.

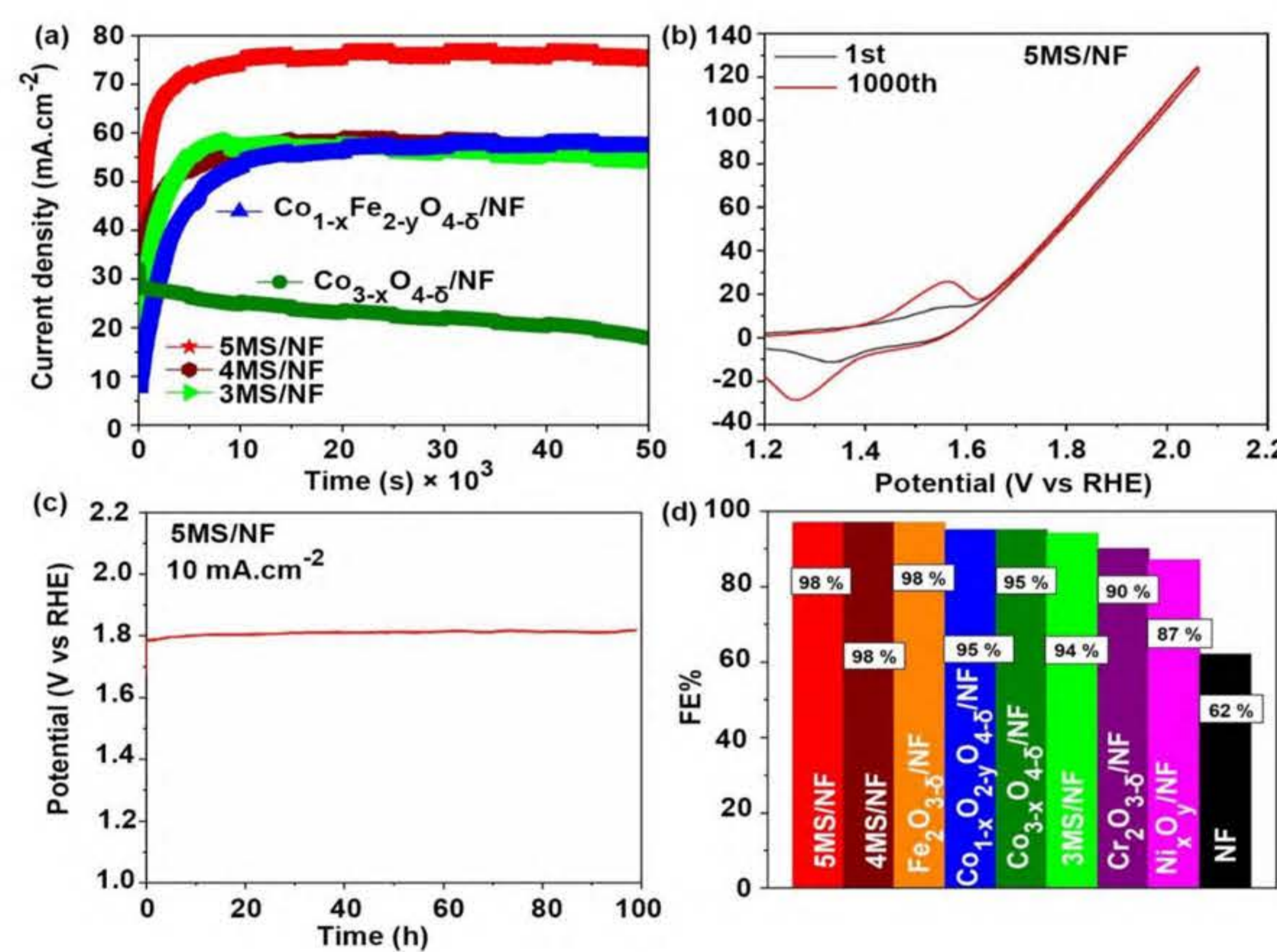


Figure 6 Stability and efficiency of catalysts for OER (a) chronoamperometry at 1.766 V (vs RHE) (b) ADT for 1000 cycles (c) chronopotentiometry with uncompensated solution resistance and (d) Faraday efficiency for 4000s.

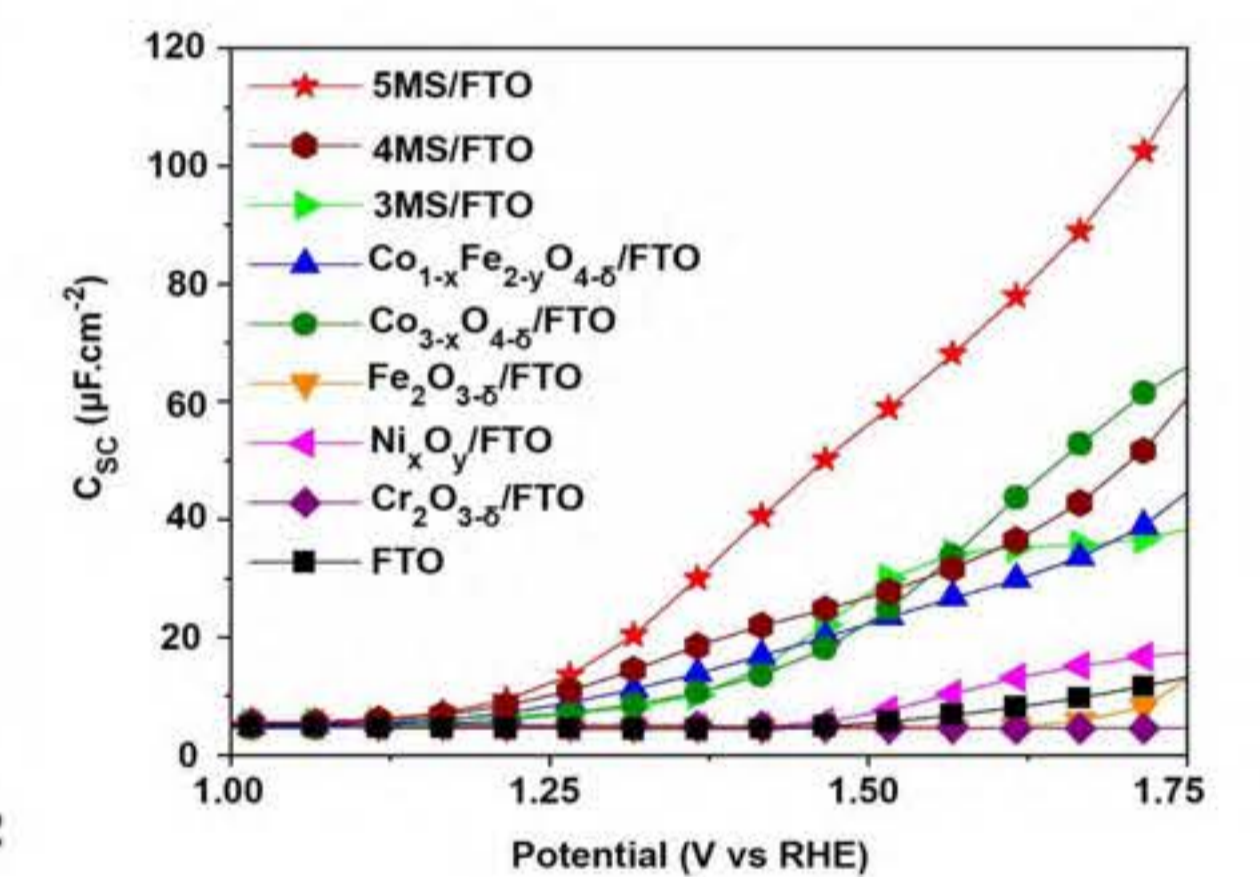


Figure 5 Space charge capacitance measurement inside 1 M KOH (0.49 mg.cm<sup>-2</sup> mass loading).

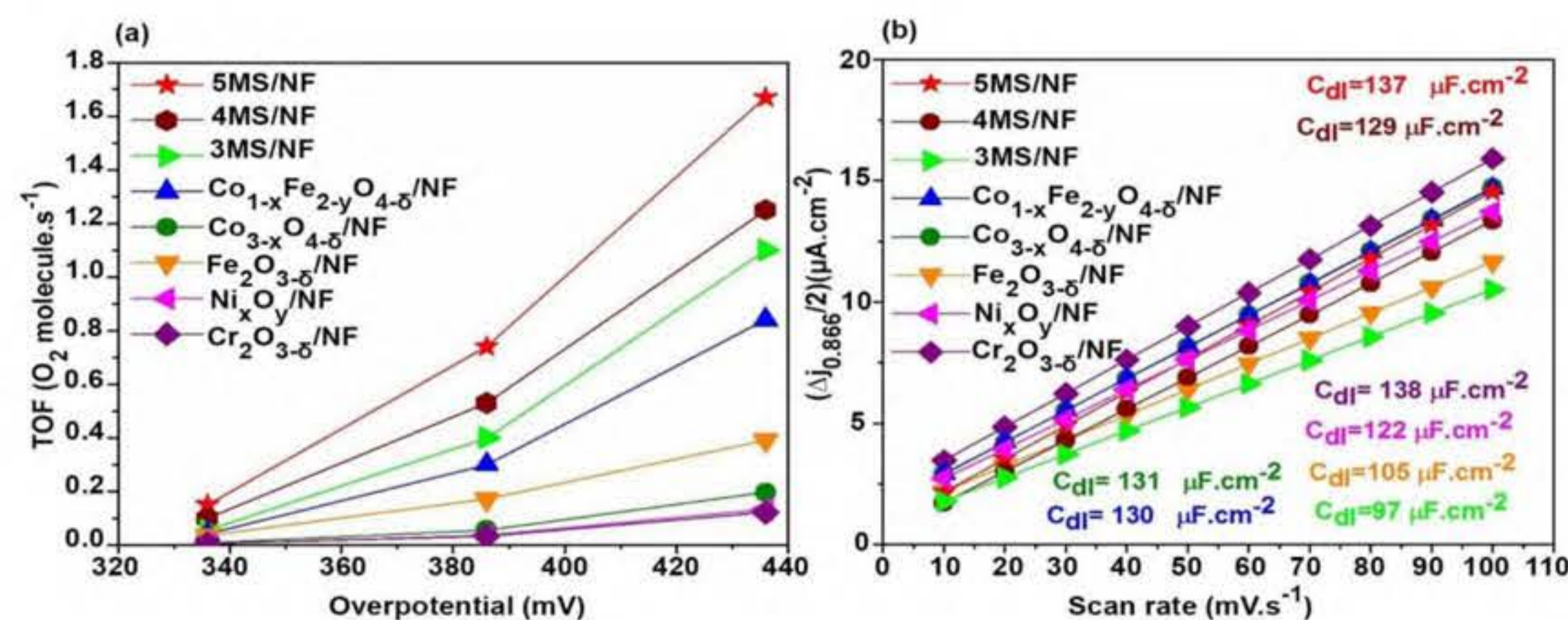


Figure 4 Chemical adsorption and physical adsorption for determining (a) Turnover frequencies of oxygen molecules by measuring reduction peak area of CV and (b) double layer capacitance measurement in the non-faradaic region.

### Conclusion

Multi-metallic spinel (5MS) containing Al, Cr, Co, Ni, and Fe with an average grain size around 4 nm, were synthesized using the sol-gel autocombustion method. This spinel demonstrates remarkable reactivity, stability, and selectivity for the OER in an alkaline environment coming from space charge, interfacial and hopping polarization. Mild covalency and small distance between active site can also some other reasons for improvement of performance.



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