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Insight into the ammonia decomposition/oxidation kinetics in ammonia protonic ceramic fuel cells via elementary modeling

Jiacheng You[1], Jiangping Chen[1], Shunli Liu[1], Huihuang Fang[1], Fulan Zhong[1], Yu Luo[1], and Lilong Jiang[1]

[1]Fuzhou University

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Abstract

Protonic ceramic fuel cells (PCFCs) can efficiently convert the chemical energy of fuel into electricity, with alternative fuel range. Ammonia has been regarded as a promising fuel for PCFCs due to its carbon-free and hydrogen-rich properties and easy storage/transportation. However, the performance of ammonia PCFCs (NH3-PCFCs) is inferior to the hydrogen PCFCs (H2-PCFCs) because of sluggish and complex kinetics at anode. In this work, we establish an elementary reaction kinetic model for NH3-PCFCs, investigate the effect of reaction parameters, and explore the coupling mechanism between the ammonia decomposition and electrochemical reaction. Importantly, the ammonia decomposition and electrochemical reaction can be regulated by adjusting anode parameters, then affecting the performance ratio of NH3-PCFCs and H2-PCFCs. Thus, the ammonia-hydrogen performance ratio of the cell can exceed 95% at 550 after accelerating the ammonia decomposition reaction. Our work provides insights into the kinetics in NH3-PCFCs for improving their performance with optimization.

Highlights

1. An elementary reaction model for ammonia protonic ceramic fuel cells was proposed.
2. Complex ammonia decomposition/electrochemical reaction steps were deconvoluted.
3. The ammonia-hydrogen performance ratio reaches 95% by accelerating ammonia decomposition at anode.
4. Anode parameters affect cell performance by affecting the ammonia decomposition and charge transfer reaction.
5. Strategies for the subsequent design of ammonia protonic ceramic fuel cells were proposed.

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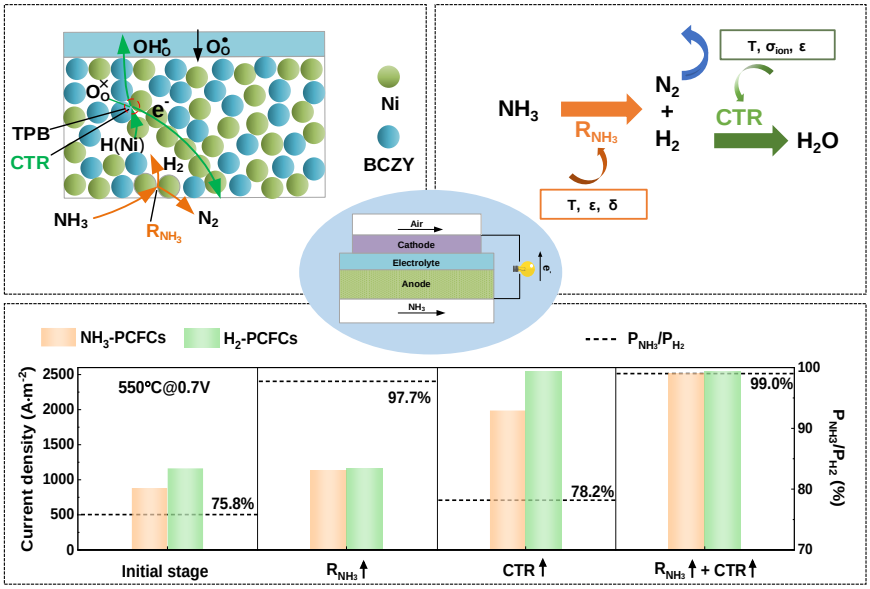

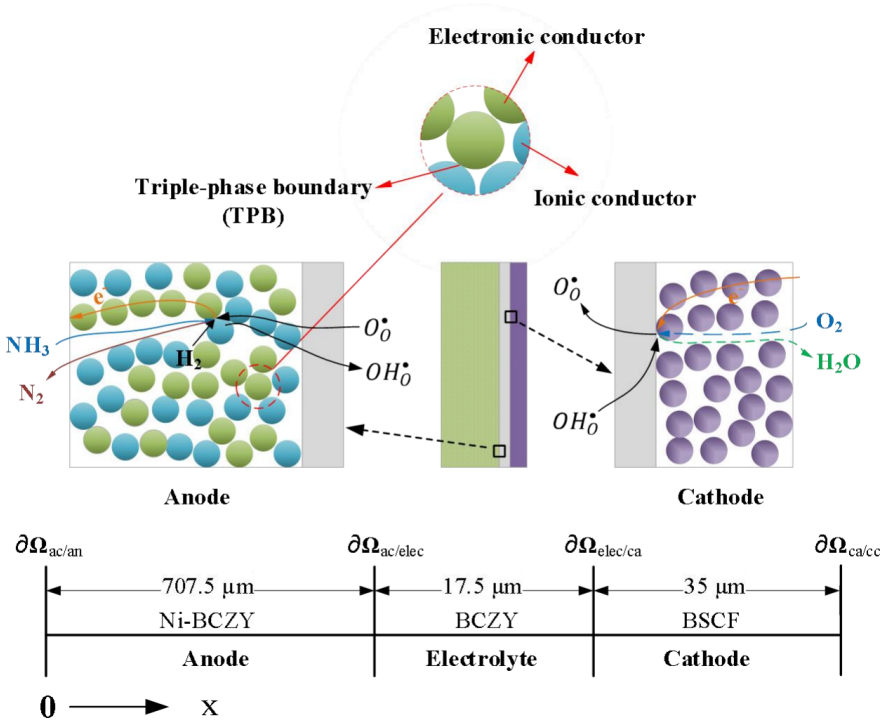

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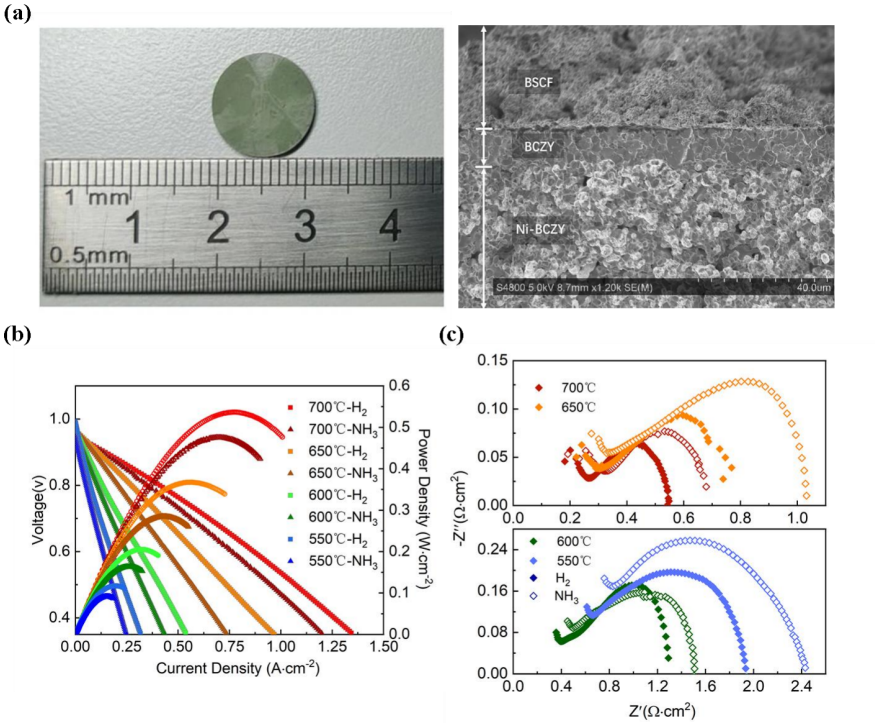

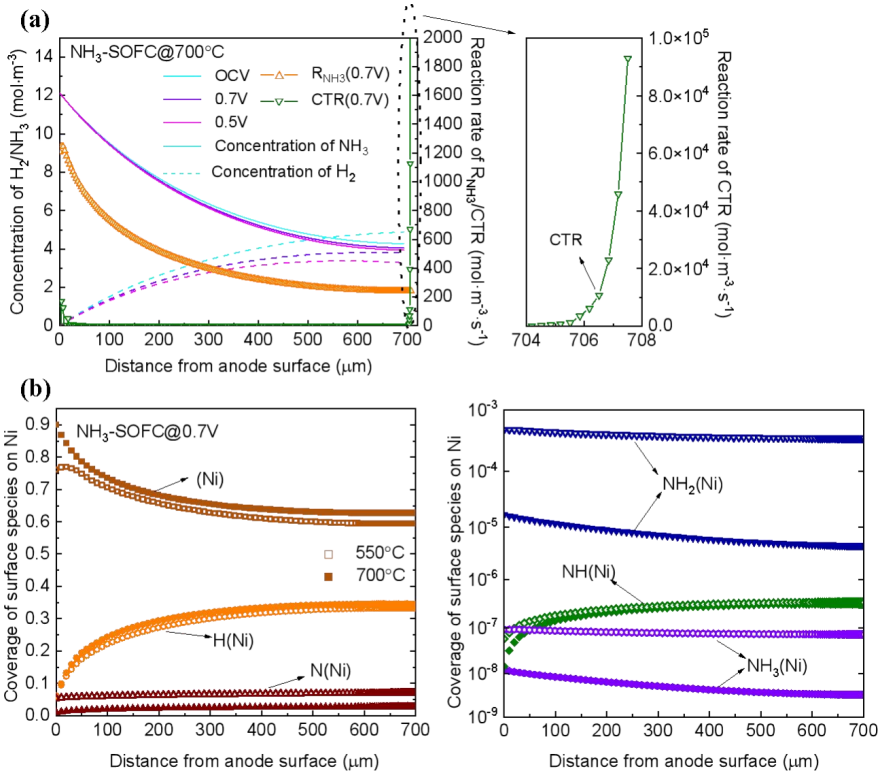

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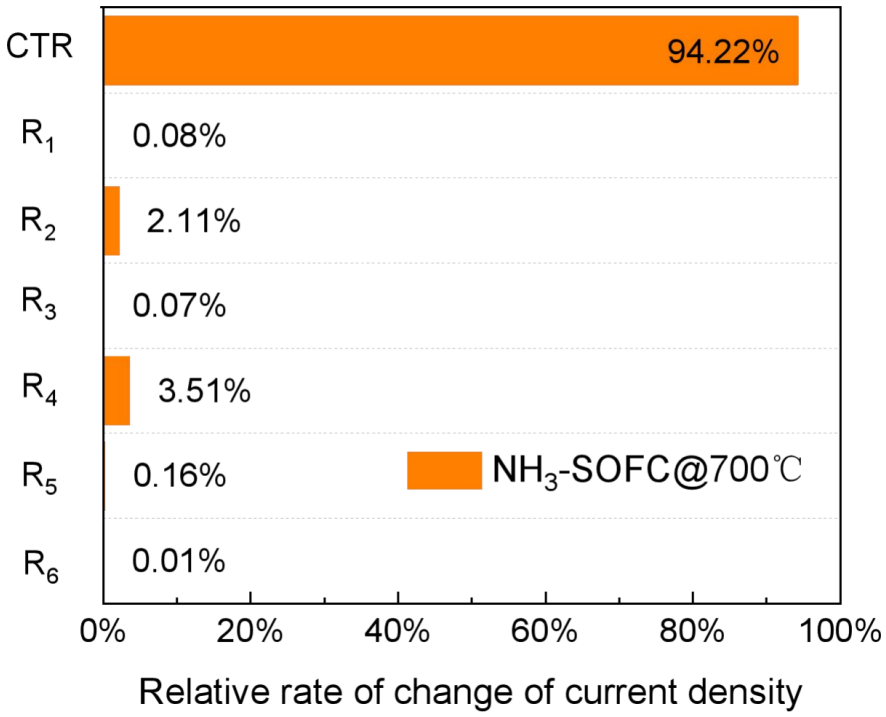

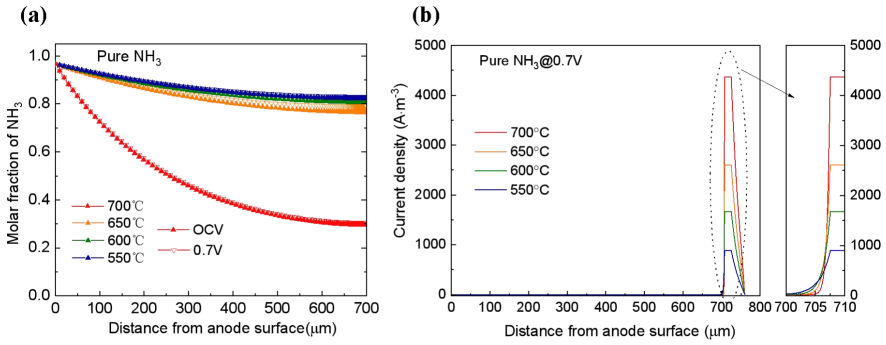

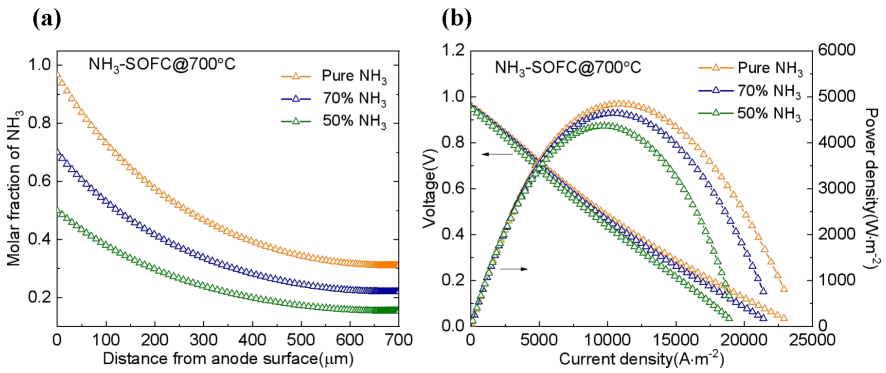

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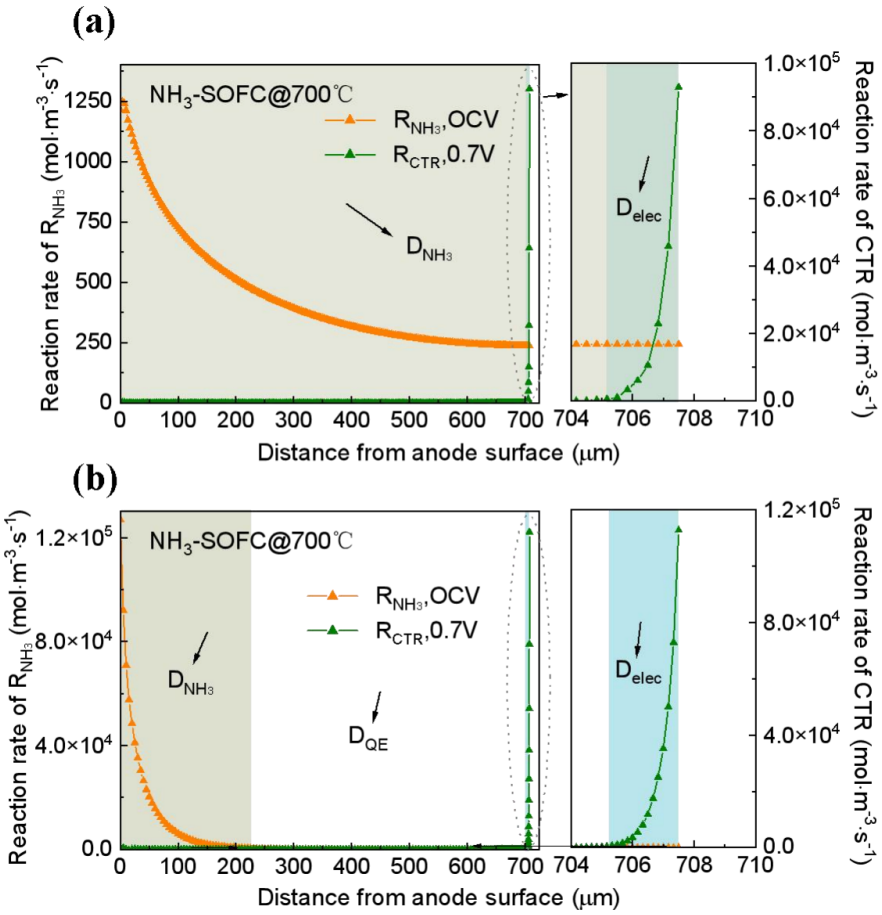

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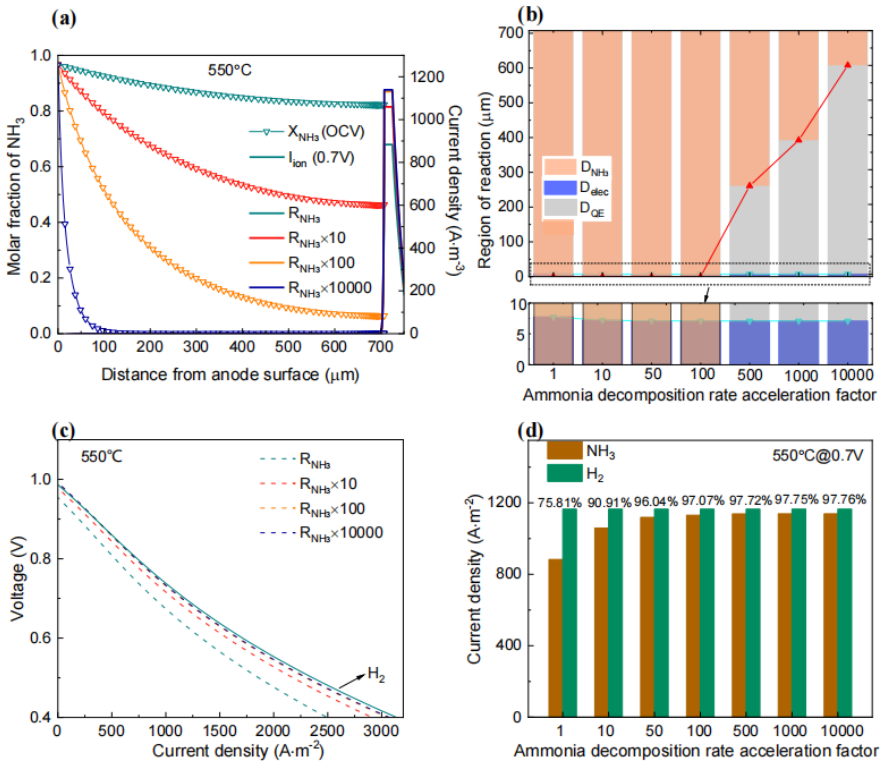

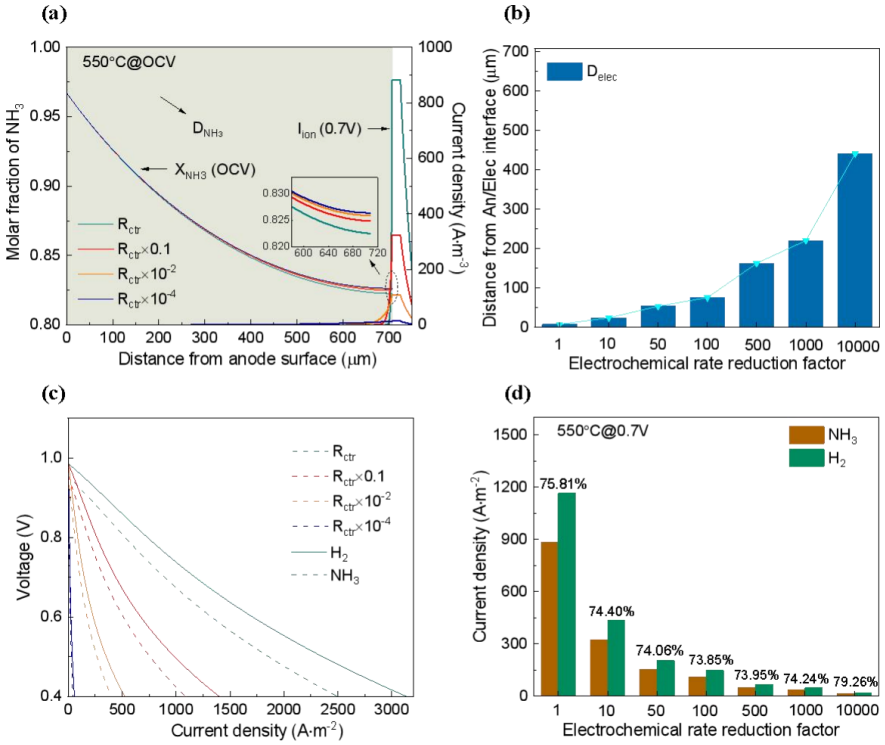

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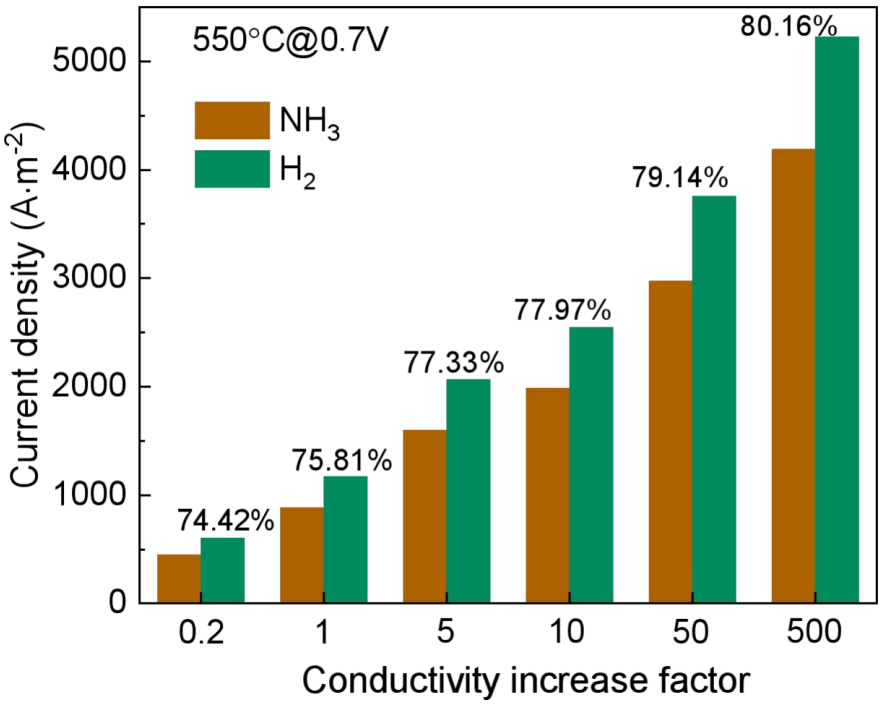

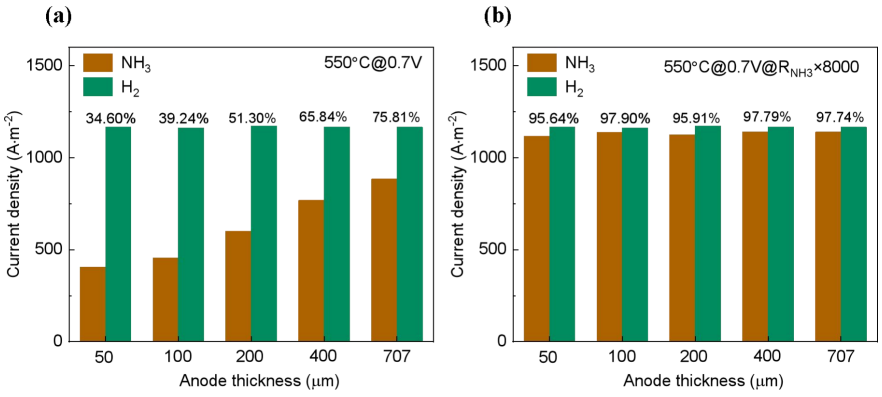

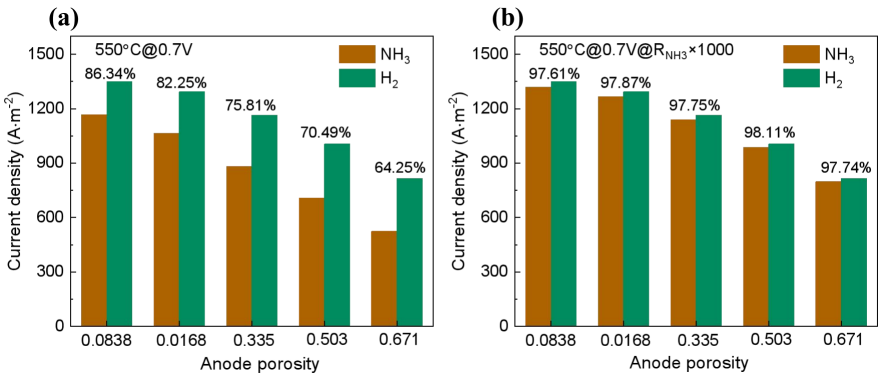

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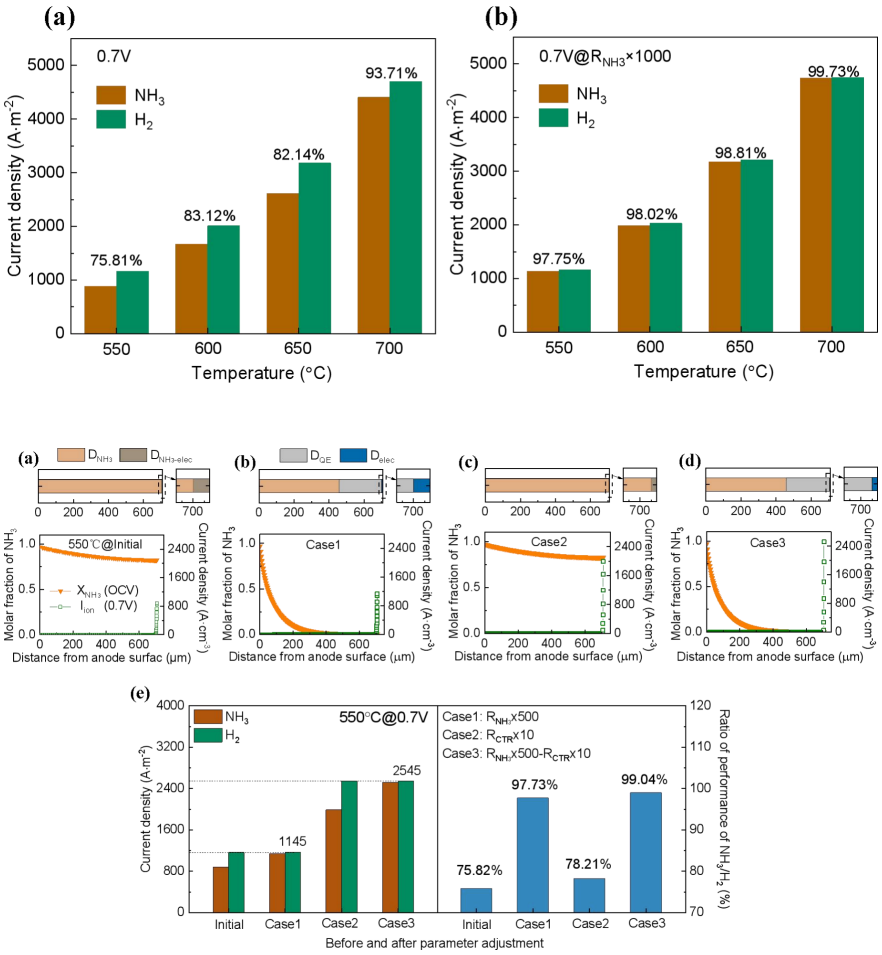

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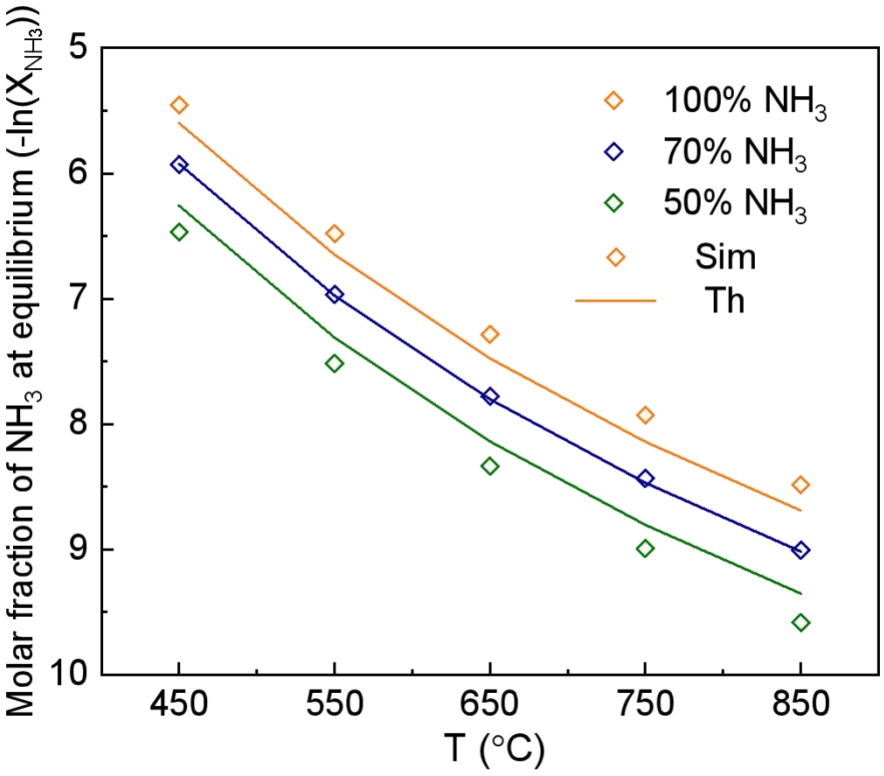

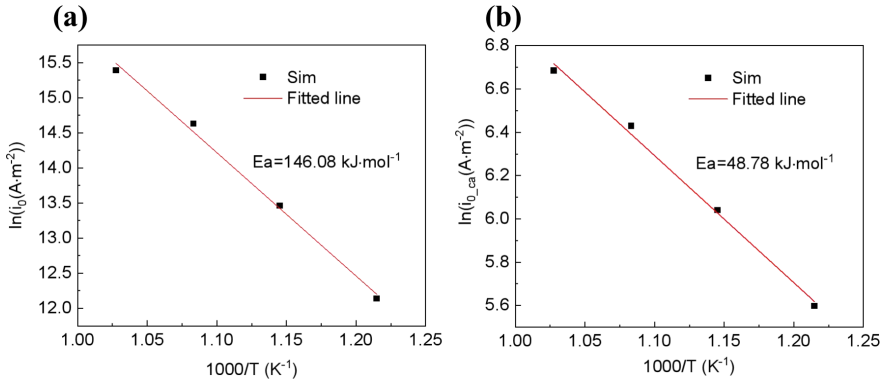

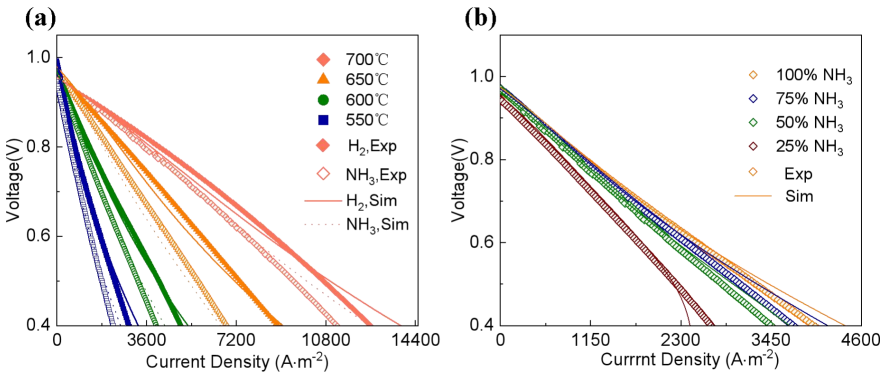

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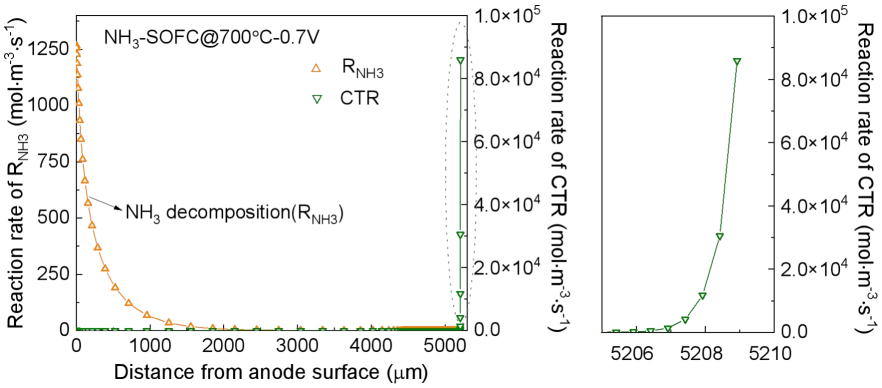

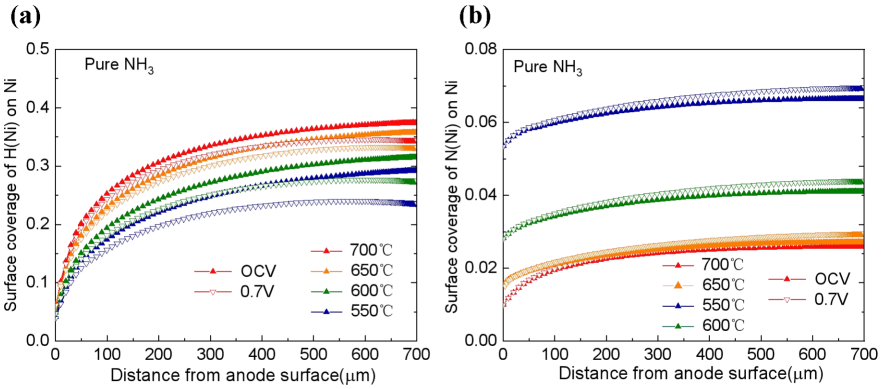

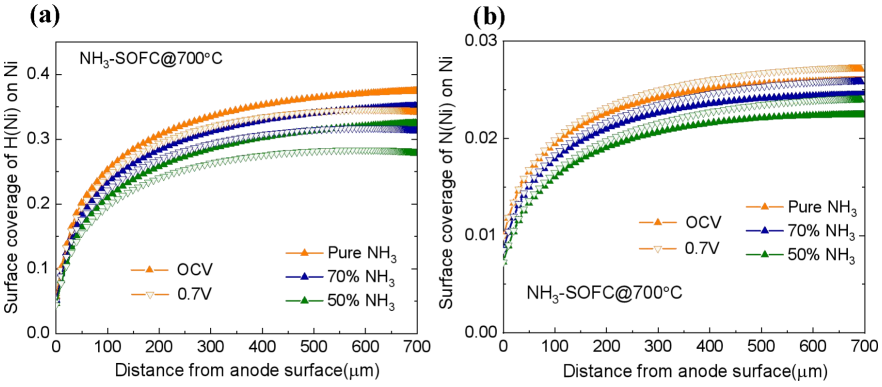

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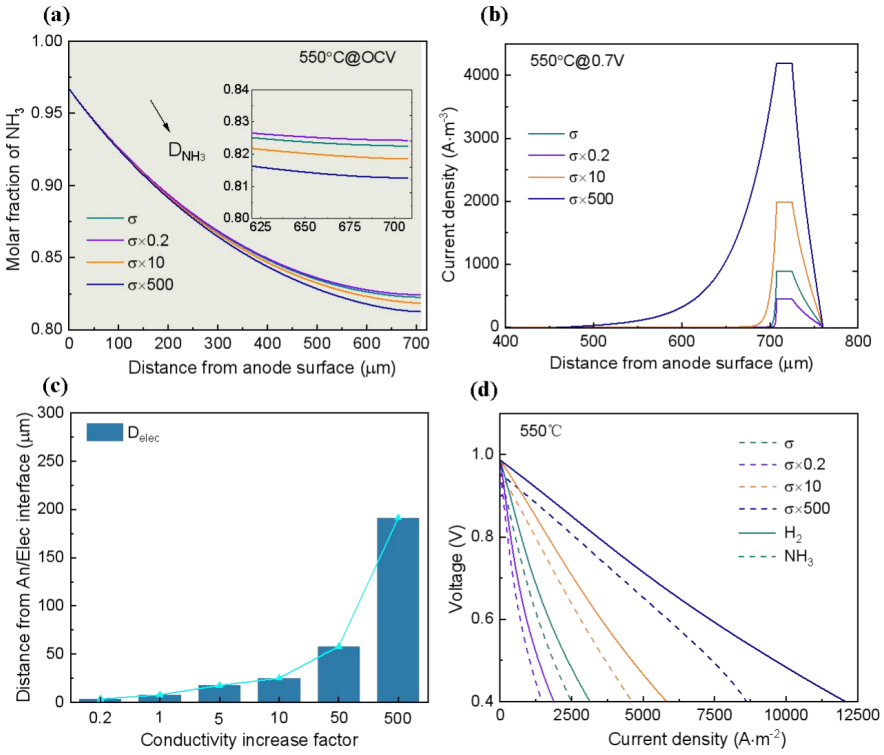

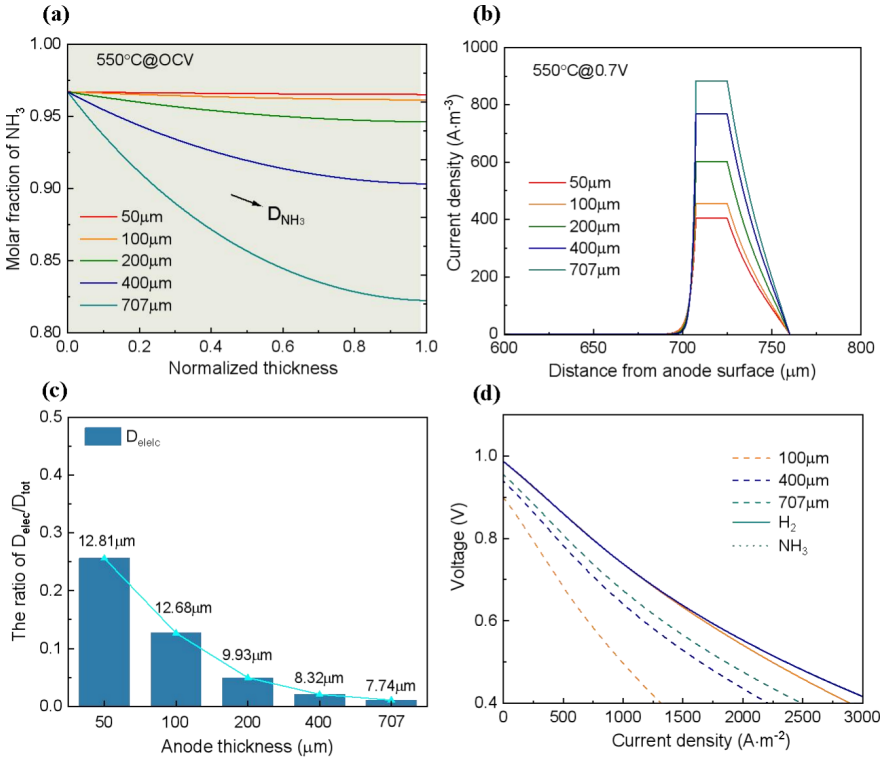

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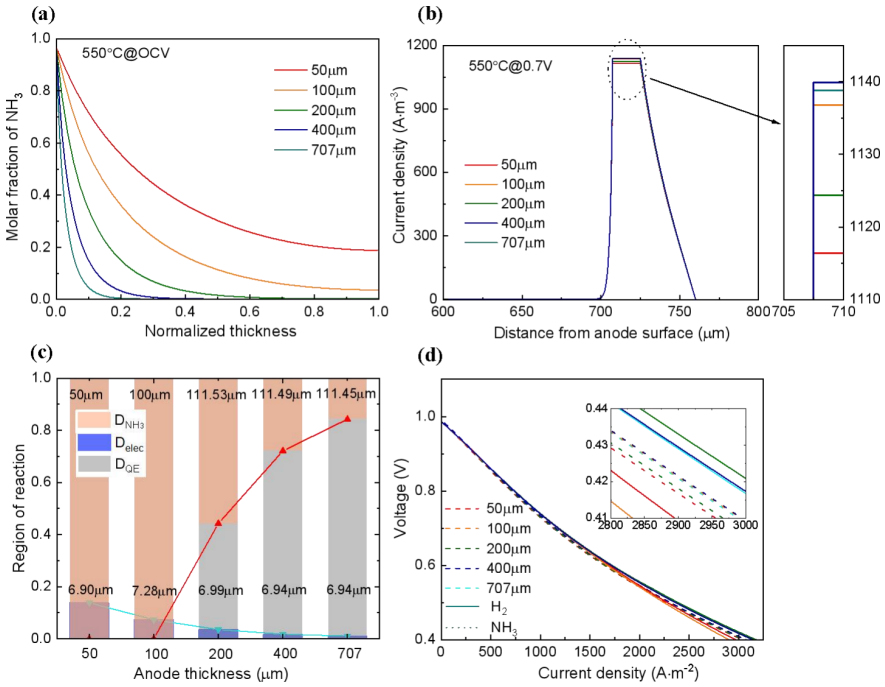

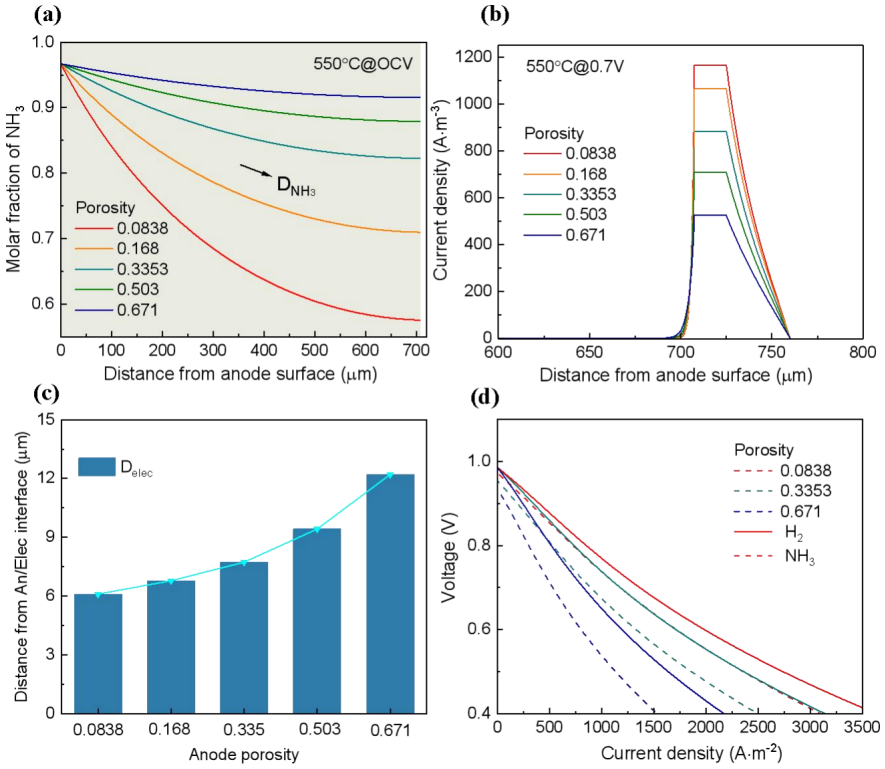

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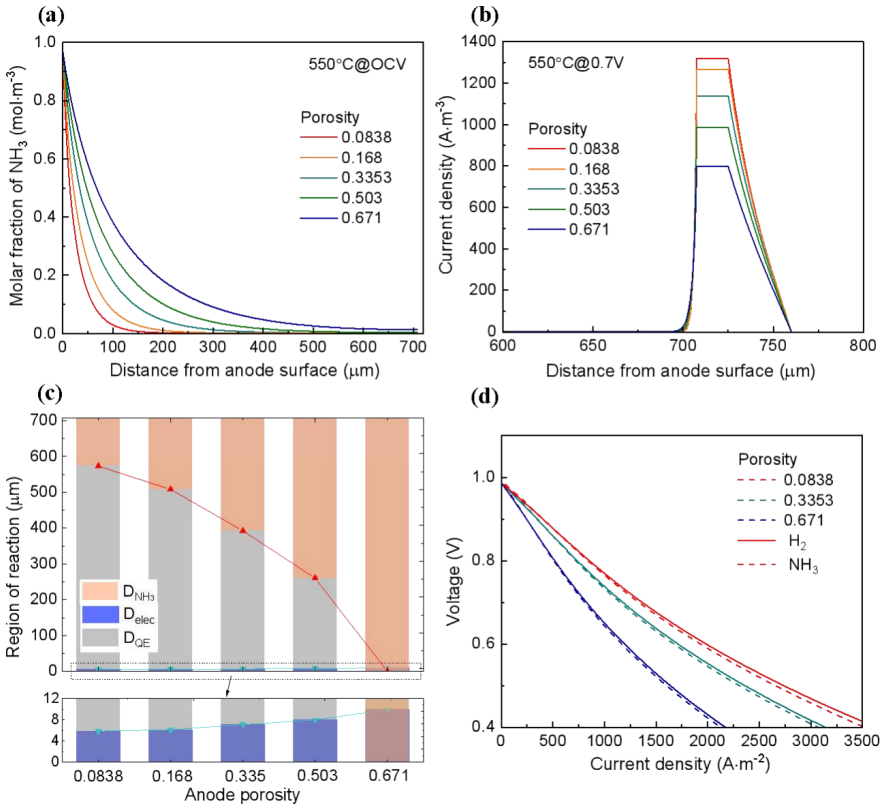

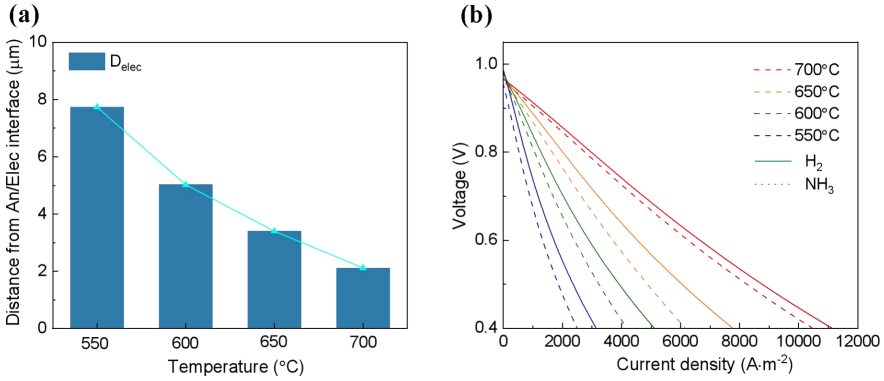

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