Obtaining Electrokinetic Data of Oxygen Electrodes in Solid Oxide Cells

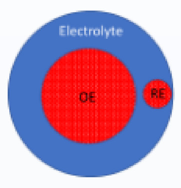
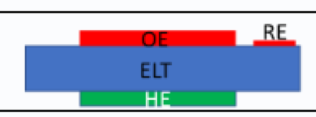
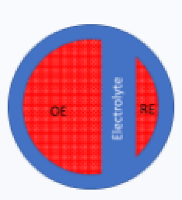
Yeting Wen, Jiaxin Lu and Kevin Huang

Department of Mechanical Engineering
South Carolina SmartState Center for Solid Oxide Fuel Cells
University of South Carolina, Columbia, SC29201

INTRODUCTION

Electrode overpotentials determine the performance of all electrochemical devices such as fuel cells, electrolyzers and batteries. Unlike liquid-based electrochemical systems, in which a reference electrode can be readily used for separating electrode overpotentials, solid-based electrochemical systems, particularly those operated at high temperatures, present a serious challenge to apply reference electrode. This poster illustrates a new 3-electrode methodology (Symmetrical Three Electrode Cell or STEC) for separating overpotential of an oxygen electrode operated under oxygen evolution reaction (OER) and oxygen reduction reaction (ORR) in high temperature solid oxide cells.

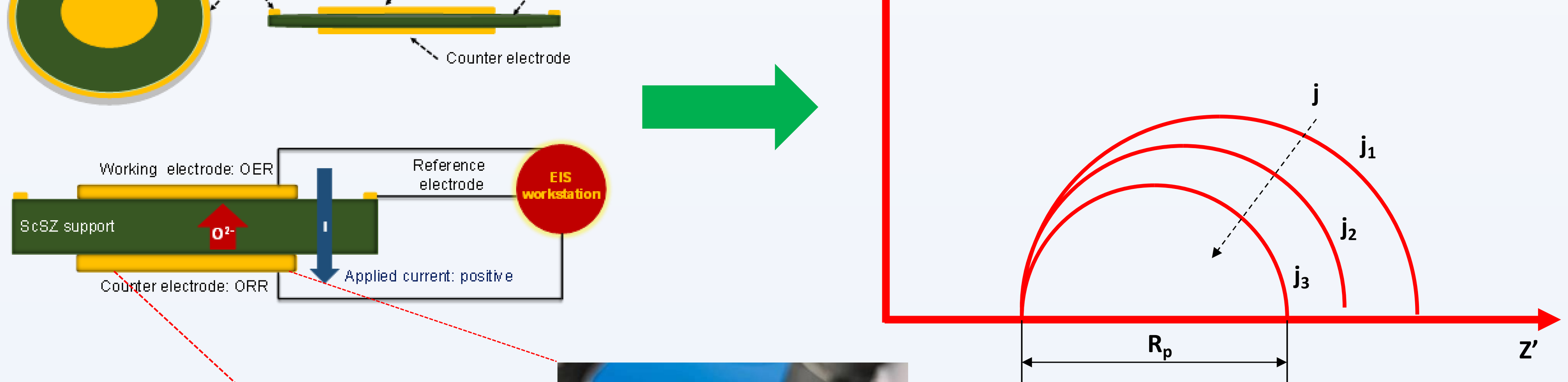
THEORETICAL ANALYSIS ON 3-ELECTRODE CONFIGURATION

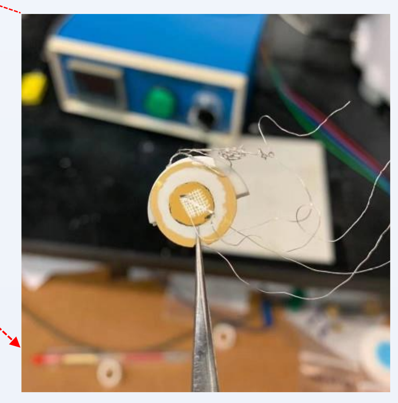
Top View	Cross-Section	Potential @ RE	Potential @ middle of ELT@0.4A/cm²	Validity for 3-Electrode Measurement
		-0.310V	-0.310V	Valid
		-0.307V	-0.307V	Valid
		-0.240V	-0.240V	Valid
		0V	-0.307V	Invalid
		0V	-0.250V	Invalid
		-0.307V	-0.307V	Valid
		-0.270V	-0.307V	Error

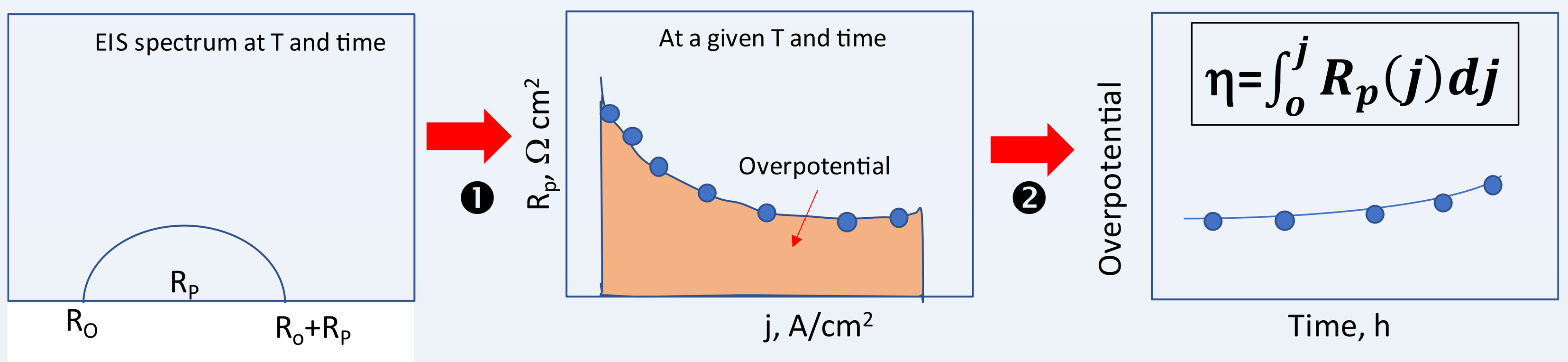
EXPERIMENTAL SETUP AND PROCEDURE

DC-biased EIS method

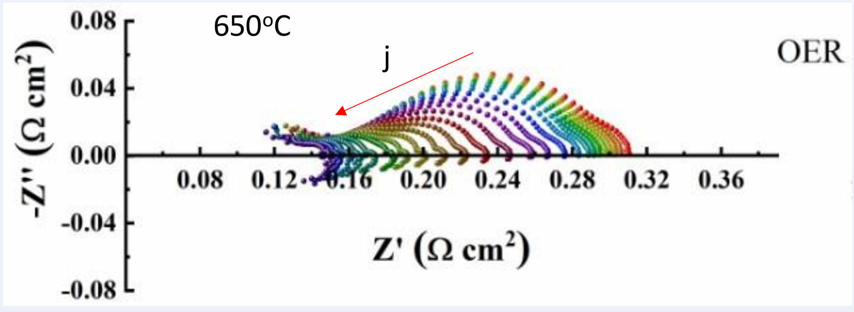
$$\eta=\int_o^j R_p(j)dj$$

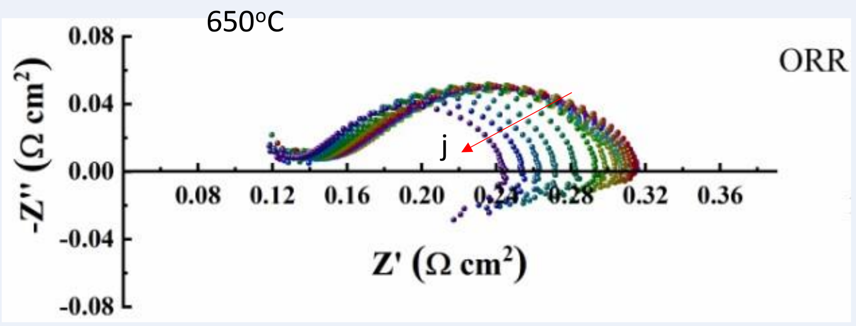




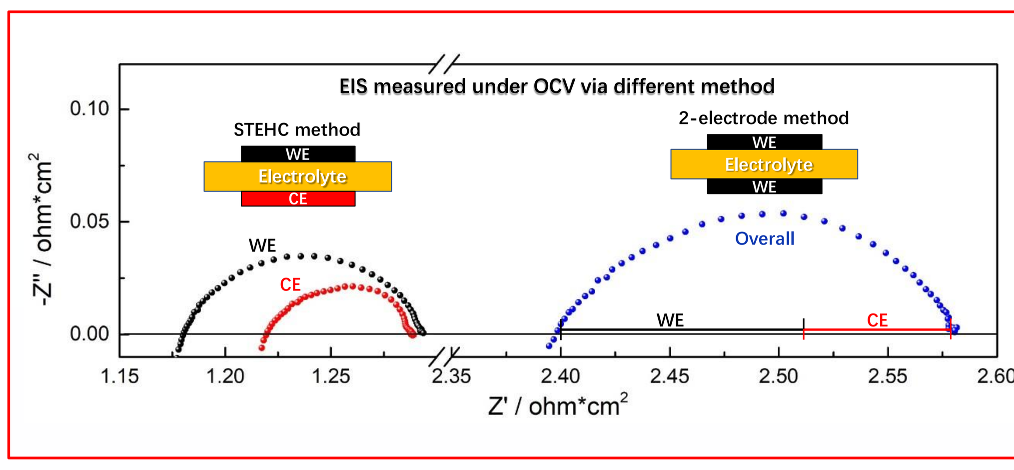


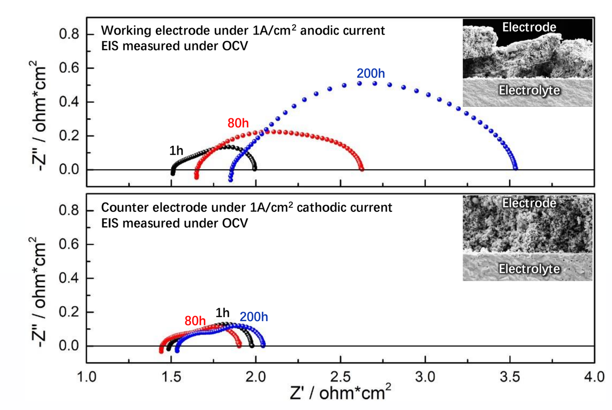
EXAMPLES OF EIS SPECTRA



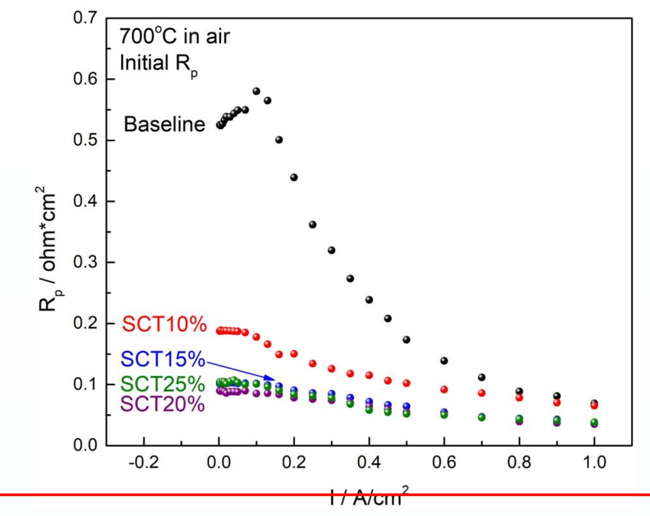


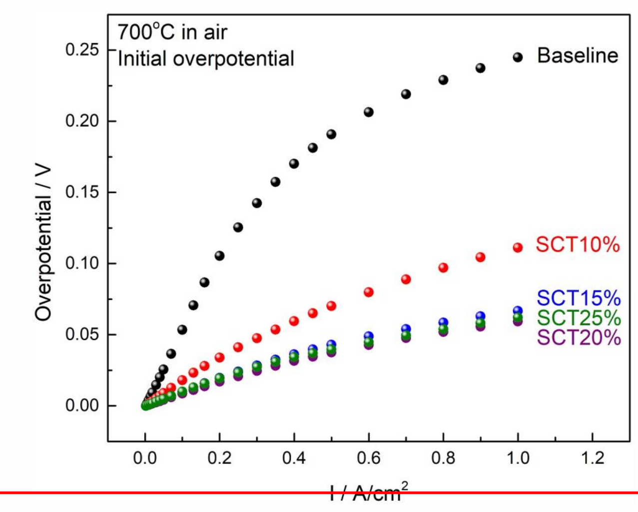
RESULTS





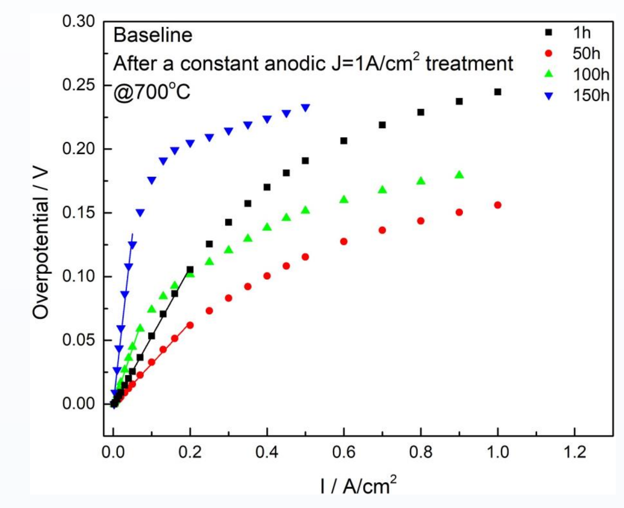
R_P-j

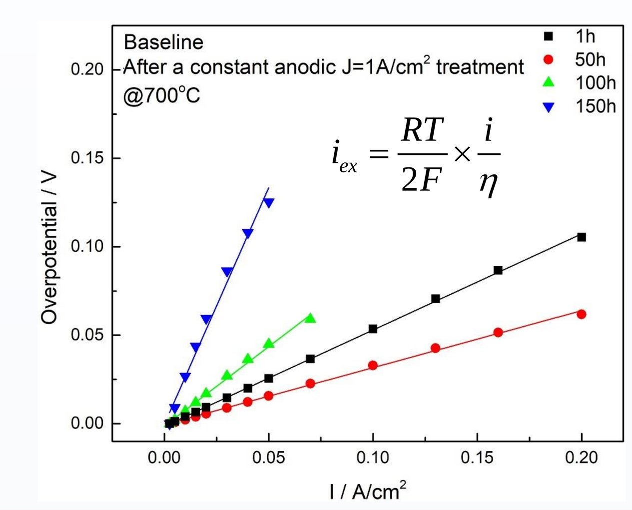




η-j

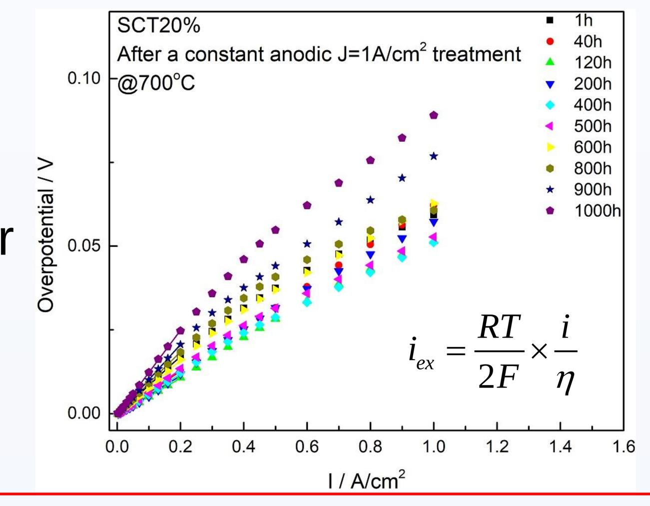
η-j-t

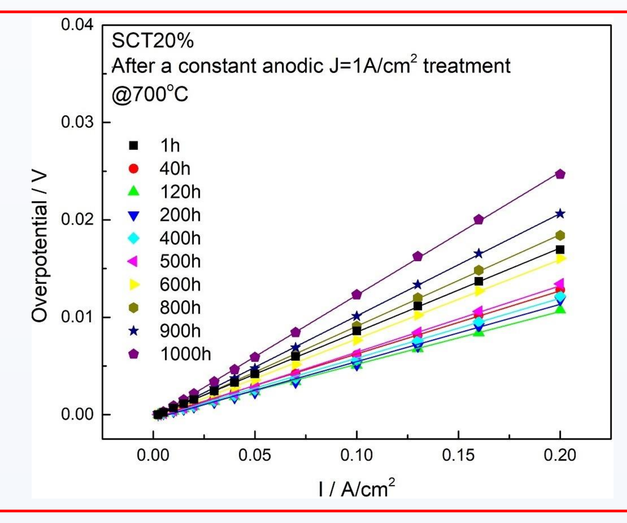




$$i_{ex}=\frac{RT}{2F}\times\frac{i}{\eta}$$

Bilayer





CONCLUSIONS

- A new STEC method has been successfully demonstrated to separate overpotentials and extraction of i_{ex} of electrodes
- Using STEC method, the baseline LSCF+GDC and bilayer SCT@LSCF+GDC have been shown with very different i_{ex}
- The limitation of STEC is the low accuracy at high current density due to instrument limitations (narrowed bandwidth at higher DC bias)

REFERENCES

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2. Yongliang Zhang and Kevin Huang et al., "Intermediate Temperature Solid Oxide Cell with a Barrier Layer Free Oxygen Electrode and Phase Inversion Derived Hydrogen Electrode", Journal of the Electrochemical Society, in honor of Prof. Goodenough's Centenarian Milestone, 2022, **169**, 034516.

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