Standard Operating Procedure

(SOP)

Measurement of Linear Thermal Expansion of SOEC Materials

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Rev 1

Jeffry Stevenson, Lab Fellow	03-08-2019
Prepared By: NAME / TITLE	Date
Approved By: NAME / TITLE	Date
Approved By: NAME / TITLE	Date

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Revision History

This page documents the revisions over time to the SOP. The most recent iteration should be listed in the row space, with consecutive versions following.

Date of Revision	Page(s)/Section(s) Revised	Revision Explanation
04/11/2019	All	First Release

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3. Procedures

a. Scope and Applicability

Measurement of the linear thermal expansion of solid materials can provide useful information regarding the compatibility of various materials during device fabrication and device operation (especially in regard to operation involving thermal cycles).

b. Summary of Method

Linear thermal expansion can be measured via a number of methods; push-rod dilatometry using commercial dilatometers is probably the most commonly used approach.

c. Definitions

SOEC: Solid Oxide Electrolysis Cell.

d. Health & Safety Warning

Read manufacturer safety warnings. Always follow dilatometer manufacturer operating procedures.

h. Equipment and Supplies

Commercial dilatometer
Calibration standard
Test specimen to be evaluated.

i. Step by Step Test Procedure

- Instrument or Method Calibration and Standardization – Following manufacturer instructions, calibrate the dilatometer prior to performing measurements on test specimens. For calibration, use an appropriate standard specimen; these are frequently provided by the manufacturer. If a large number of measurements are to be performed, the instrument should be re-calibrated periodically to assure accuracy of results.

- Sample Preparation – The length of the test specimen should be within the range specified by the equipment manufacturer. Surfaces perpendicular to the direction of measurement should be clean, flat and parallel to each other. The specimen should be sufficiently strong and rigid that the pressure of the dilatometer pushrod will not cause bending or fracture of the specimen. Reference reading is recommended [1, 2].

- Measurement of Thermal Expansion – Follow the manufacturer's instructions when performing thermal expansion measurements. For the electrode related studies, the upper test temperature range should be close to the intended sintering temperature of the electrode on the electrolyte and vice a versa.

- Data Acquisition – Most commercial dilatometers come with software and computer interfaces enabling automatic collection of dilatometric data (i.e., change in specimen length as function of time, temperature, and/or atmosphere).

4. Quality Control and Quality Assurance Section

Best results are achieved by performing multiple measurements on a given specimen, followed by averaging of the results. If possible, multiple measurements on multiple nominally identical test specimens should be performed.

5. Reference Section

1. ASTM E228 – 17, Standard Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer.
1. Handbook of Thermal Analysis and Calorimetry, Volume 6, 2018, Pages 103-129.