Thermo-Mechanical Behaviour of Multi-Layered Ceramic Systems for SOFCs
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ABSTRACT
SOFCs have to withstand considerable mechanical and thermal stresses during production and especially during operation. Mechanical failure of one cell is enough to damage the whole stack, threatening the lifetime and efficiency of the entire system. Thus, it is of high importance to gain knowledge on the mechanical properties of the cell, improving the reliability and durability of SOFC technology.
In this study, the overall behaviour of an electrolyte supported cell has been investigated. Destructive and non-destructive tests have been performed. Results show that the elastic moduli of the cell continuously decreases with the increasing number of layers.

INTRODUCTION
SOFCs opened a way for a necessary revolution in the power generation industry; hence, the importance of the development and improvement of these devices.
- **Focus**: Layered structure of SOCs
- **Goal**: Investigation of the overall elastic behaviour of the MEA

Overall properties of MEA (Membrane Electrode Assembly) are affected by constraints arising between layers, co-sintering effects and interfaces.
- **Methodology**: Layers added one by one
  - Destructive and non-destructive tests
  - Comparison of the behaviour between consecutive samples
  - Laminate theory

MATERIALS AND METHODS

**Stack**

Components:
- Air Electrode
- Electrolyte
- Fuel Electrode
- Metal Sheet
- Repetition Units

**Room temperature**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC0</td>
<td>Electrolyte</td>
</tr>
<tr>
<td>SOC1</td>
<td>Electrolyte + GDC Barrier</td>
</tr>
<tr>
<td>SOC2</td>
<td>Electrolyte + GDC + Fuel Electrode</td>
</tr>
<tr>
<td>SOC3</td>
<td>Electrolyte + GDC + Electrodes</td>
</tr>
</tbody>
</table>

- **Impulse Excitation Technique (IET)**
  - Device: IMCE NV, Genk, Belgium
  - Samples: Rectangular bars (13 x 5 x 1) mm
- **Three-Point Bending test (3PB)**
  - Device: INSTRON 8862 Norwood, MA, USA
  - Samples: Rectangular bars (7 x 1) mm, 16 mm span
- **Tensile test**
  - Device: INSTRON 8862 Norwood, MA, USA
  - Samples: Bone shaped, 50 mm gauge

RESULTS

**High temperature**

- **Impulse Excitation Technique**
- **Layer Properties - Laminate Theory**

CONCLUSIONS

- Continuous decrease in Elastic moduls when adding layers to the electrolyte;
- Behaviour vs temperature getting almost constant with increasing number of layers;
- Good agreement between IET and 3PB results and between all the results for the electrolyte;
- Orthotropic behaviour of MEA observed
- Elastic Modulus of individual layers derivat-ed from tensile test results, through laminate theory principles.

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