Thermo-Mechanical Behaviour of Multi-Layered Ceramic Systems for SOFCs

Alessia Masini, Filip Siska, Oldrich Sevecek, Zdeněk Chlup and Ivo Dlouhý
Institue of Physics of Materials (IPM) AS CR, Zizkova 22, 616 62 Brno, Czech Republic

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

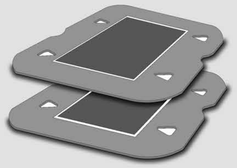
Overall properties of MEA (Membrane Electrode Assembly) are affected by constraints arising between layers, co-sintering effects and interfaces.

- **Methodology** Layers added one by one
  Destructive and non-destructive tests
  Comparison of the behaviour between consecutive samples
  Laminate theory

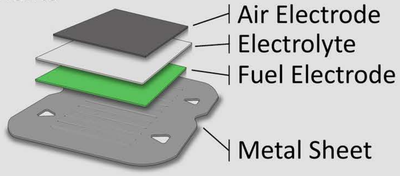
MATERIALS AND METHODS

Stack

Repetition Units



Components



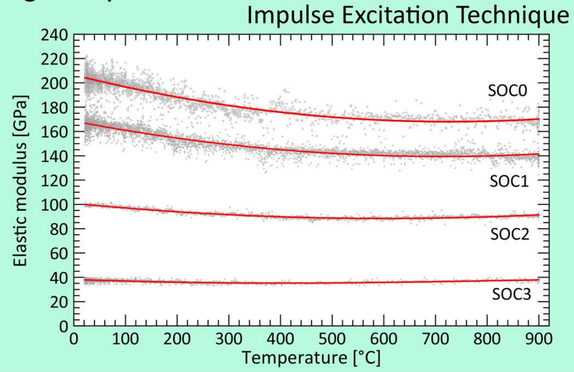
Sample	Name	Description
	SOC0	Electrolyte
	SOC1	Electrolyte + GDC Barrier
	SOC2	Electrolyte + GDC + Fuel Electrode
	SOC3	Electrolyte + GDC + Electrodes

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

RESULTS

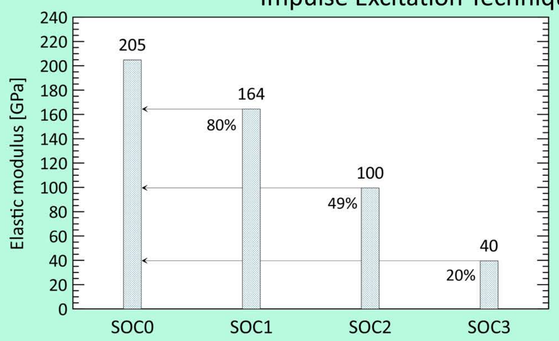
High temperature

Impulse Excitation Technique

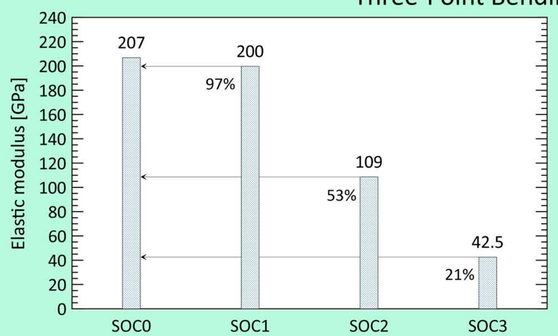


Room temperature

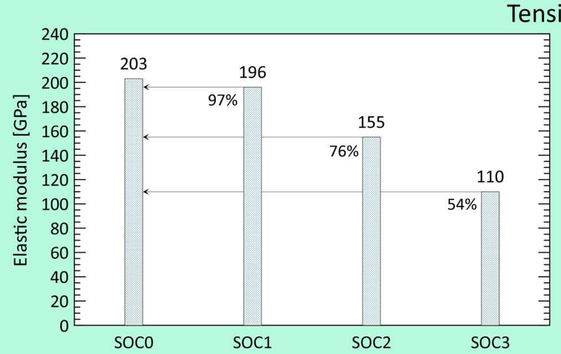
Impulse Excitation Technique



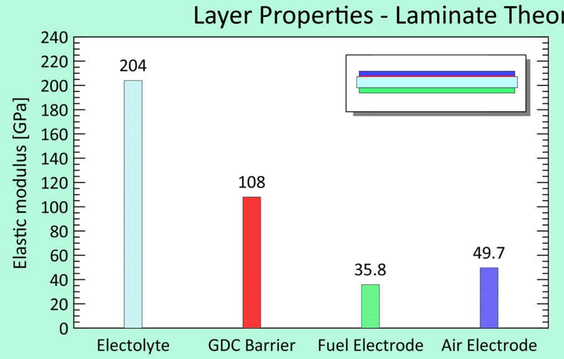
Three-Point Bending



Tensile



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 derivated from tensile test results, through laminate theory principles.

ACKNOWLEDGEMENTS

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement no 642557 (CoACH) and The Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 700300 (GrInHy).

The participation to this conference has been financially supported by ACerS Engineering Ceramics Division.

CONTACTS

Alessia Masini

Institute of Physics of Materials AS CR, Brno
Czech Republic

email: masini@ipm.cz
phone: +420 532 290 336
website: www.ipm.cz