Fuel cells and hydrogen
Joint undertaking

# SOFC-Life

## (Contract number: 256694)

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# Solid Oxide Fuel Cells – Integrating Degradation Effects into Lifetime Prediction Models

Quantification and understanding of the details of major Solid Oxide Fuel Cells (SOFC) continuous degradation effects

The goal is

- to isolate effects occurring on the anode and cathode side of SOFC and
- develope descriptions of the degradation mechanisms as functions of distinctive operating parameters (mainly temperature, atmosphere and current density).
- These functional descriptions are to represent the understanding of the degradation processes as they occur physically and chemically, i.e. as change of basic materials and layer properties over time.

# 1. Project Partners

**Start: 1 Januar 2011**
**Duration 36 months**

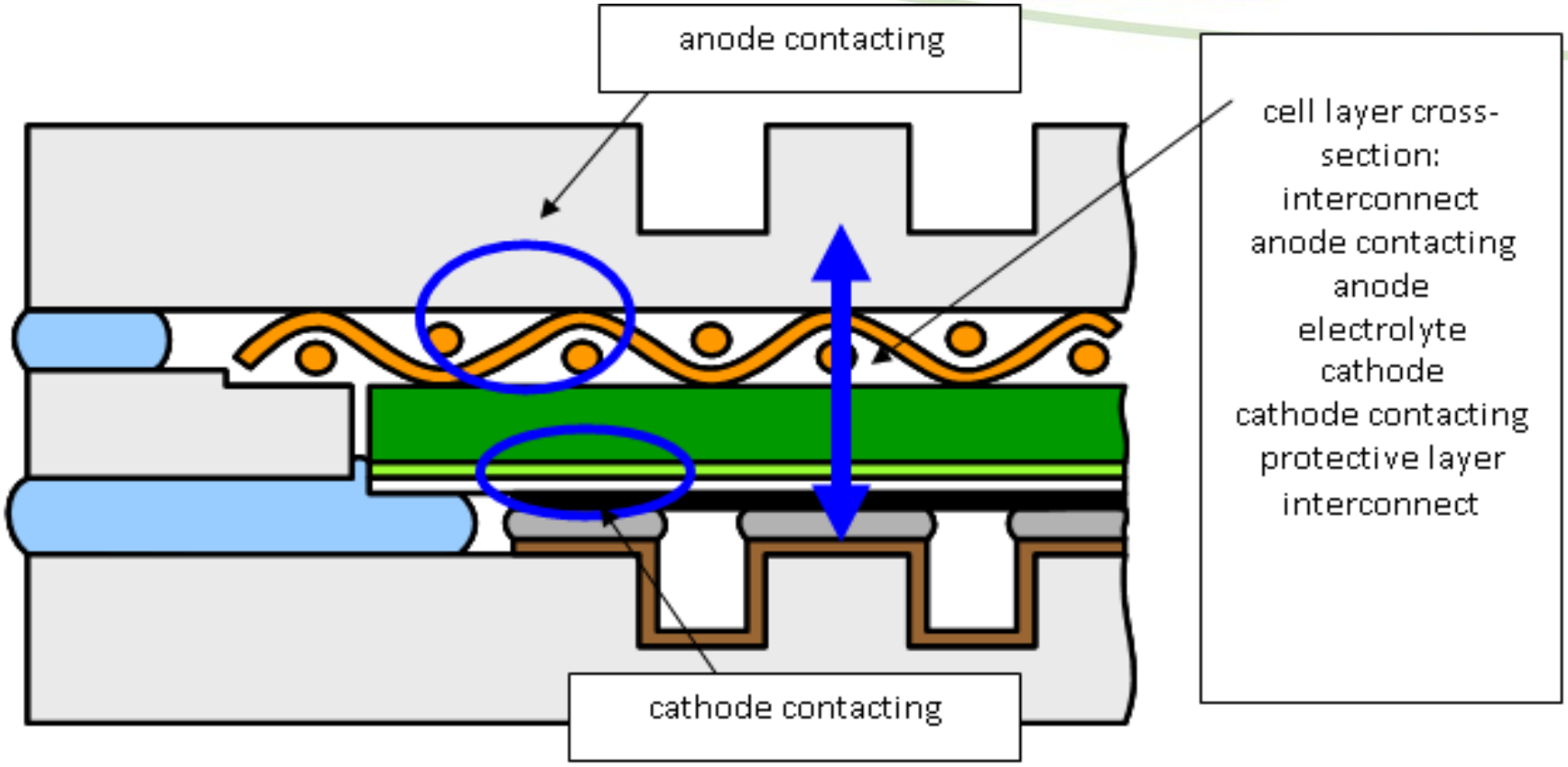
Industrial Partners:

| | |
|---|---|
| HTCeramics | Switzerland |
| Hexis | Switzerland |
| TOFC | Denmark |
| EDF | France |

Research Partners:

| | |
|---|---|
| Risoe DTU | Denmark |
| VTT | Finnland |
| CEA | France |
| FZ- Jülich | Germany |
| IHTE | Russia |
| EPFL | Switzerland |
| EMPA | Switzerland |
| ZHAW | Switzerland |
| Imperium College | UK |

## Stack repeating unit




SOFC repeating unit components to be addressed and details of the specific layers that interface with each other

# Project Approach

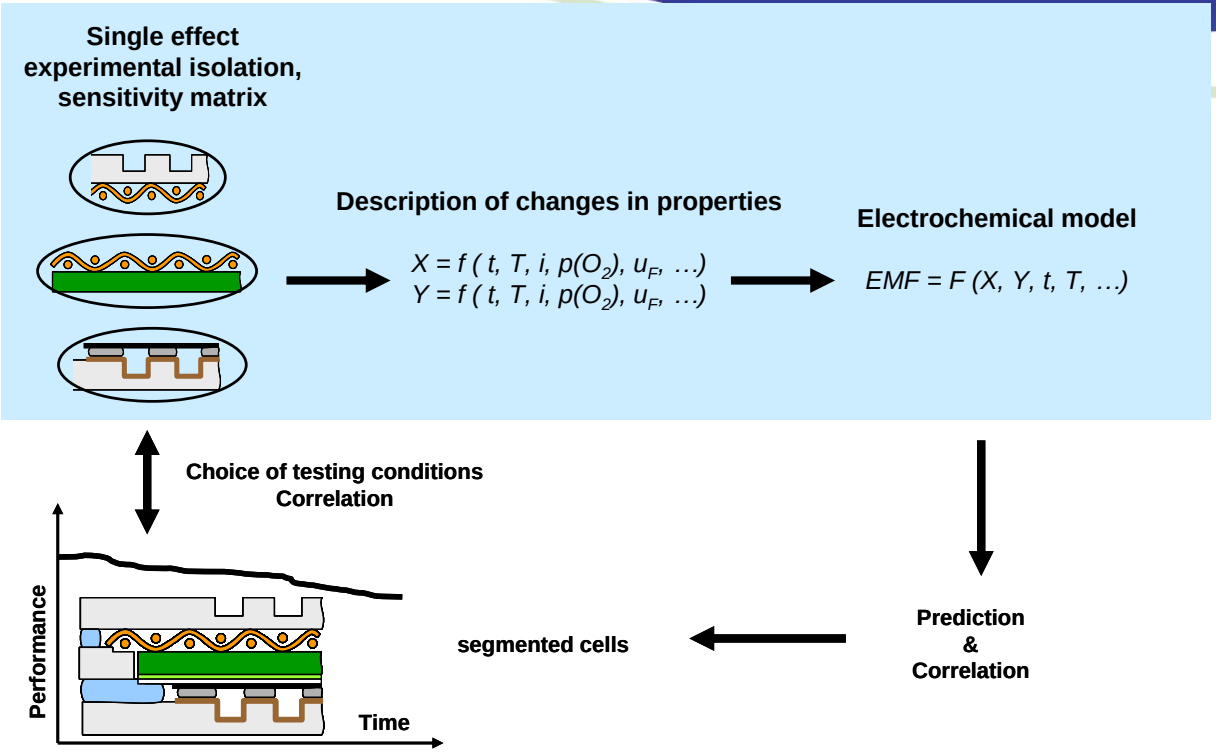
SOFC-Life addresses basic research activities directed to **degradation and lifetime** fundamentals of SOFC technology, particularly **focusing on SOFC materials available and in industrial application today**

Understanding the details of the major SOFC continuous degradation effects and developing models that will predict single degradation phenomena and their combined effect on SOFC cells and single repeating units

stacks and cells has to be deconstructed into single elements and interfaces which are considered to be the main contributors to performance loss, i.e. degradation into:

- samples representing the time evolution of the materials in the SOFC cell
- and samples including the interfaces between interconnect and cell and representing there influence

# Project Objectives and Goals

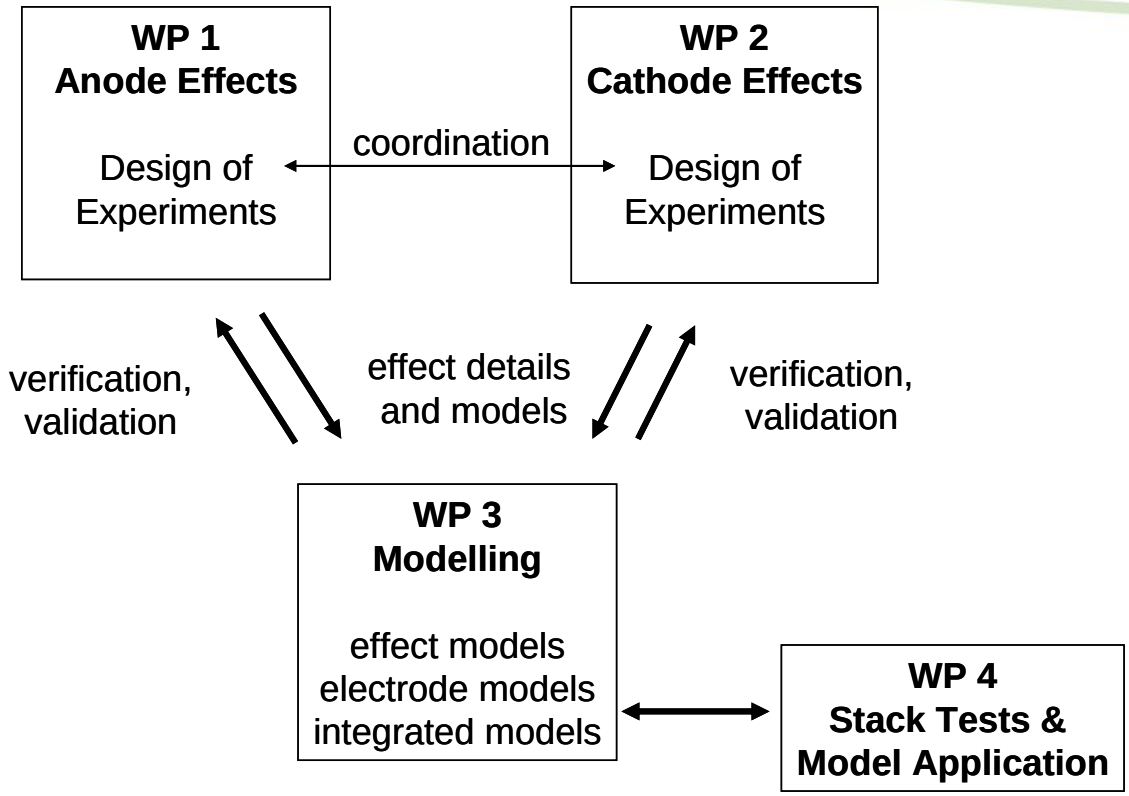



**The quantification and prediction of single contributions with respect to their behaviour over time is the key expected outcome of this project**

# Work Packages

| Work package No. | Work package title | Type of activity | Lead partner No. | Lead Participant short name | Person-month | Start month | End month |
|---|---|---|---|---|---|---|---|
| **WP 1** | Anode Side Phenomena | RTD | 1 | FZJ | 181 | M1 | **M30** |
| **WP 2** | Cathode Side Phenomena | RTD | 5 | RISOE | 122 | M1 | **M30** |
| **WP 3** | Model Development | RTD | 11 | EPFL | 171 | M1 | **M36** |
| **WP 4** | Model Application, Evaluation and Verification | RTD | 2 | HEXIS | 47 | M1 | **M36** |

# Work Packages




**Work flow diagram of work packages interaction with each other**

# Project Expected Outcome

Anode:

- history of physical and electrical change for the samples over time, correlated with the exposure conditions,
- functional description of these dependencies,
- anode side model describing the evolution of electrochemical performance over time, using the time-functions of the change in physical properties, as input to higher level modelling in WP 3.

Cathode:

- history of microstructural and electrical and electrochemical change for each sample correlated with the exposure conditions including cathode cation de-mixing effects and interface interdiffusion effects
- Construction of component model giving the description of the evolution of cathode material and cathode interconnect interface with time (up to a few 10 000 hours), as functions of temperature, $p(H_2O)$, $p(O_2)$ and current density

# Project Expected Outcome

Modelling:

Correlation of effects observed at component level with effects observed at SRU and stack level. Identification of the main processes dominating the degradation at SRU and stack level and establishment / validation of integrated models predicting SRU degradation

Validation:

The objective of this work is to apply the models developed on actual industrial components (single repeating units and short stacks) and evaluate the principle feasibility of the approaches taken and verify the correctness of the model output. This will occur in the later stages of the project in the context of integration of the model descriptions developed into their respective proprietary stack modelling software