

20.10.2014

Eco-Mobility 2014

Plansee's FCH Activities

**A3PS
Vienna**

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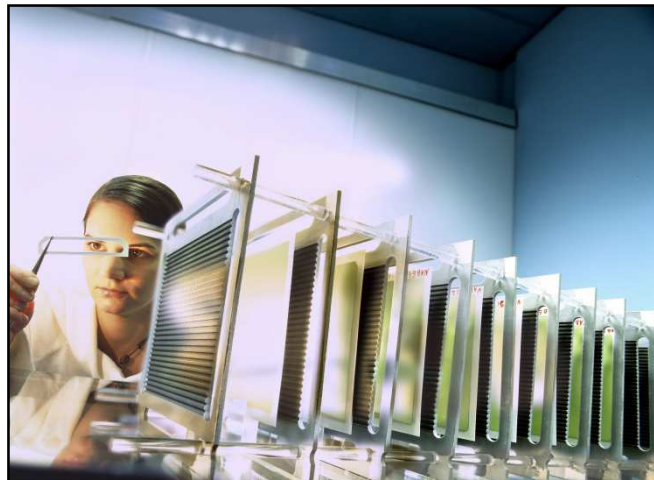
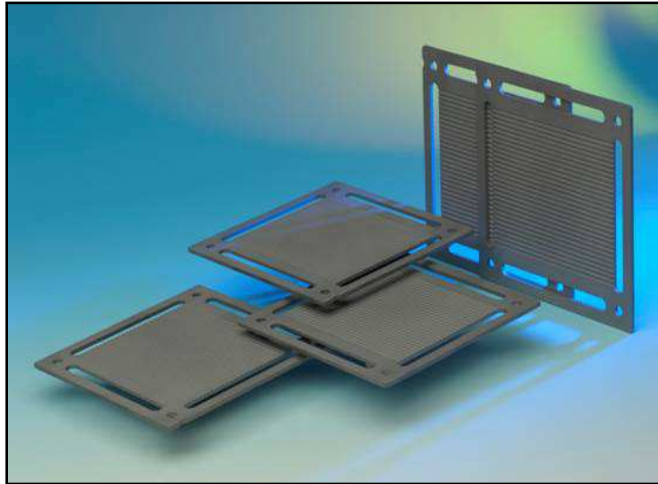
Growth Option Fuel Cell



R&D and SOFC Pilotline
at Plansee headquarters (Austria)

- 20 years of experience in SOFC
- 40 people in SOFC core team
- Continuity in R&D and investments
- Experience with industrialization of product lines and technology transfer
- Long ranging (10 years +) cooperations
- Strong scientific network

Powdermetallurgical components for SOFC stacks



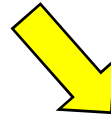
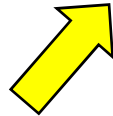
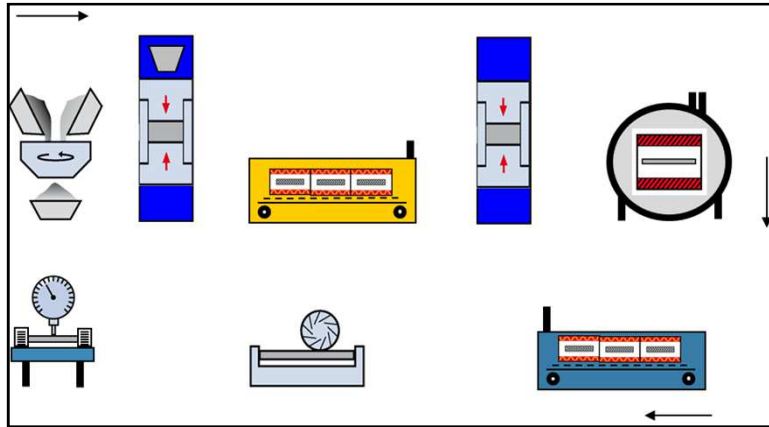
Activities of Plansee

- ESC stack concept deriving from forerunner projects with Siemens as baseline

Powdermetallurgical components for SOFC stacks

Activities of Plansee

- ESC stack concept deriving from forerunner projects with Siemens as baseline
- Development of suitable processes for the fabrication of SOFC specific powdermetallurgical alloys and processes for Cr-5(Fe1Y) stack interconnects



Gutenberg-Bibel



Printmedien

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Powdermetallurgical components for SOFC stacks



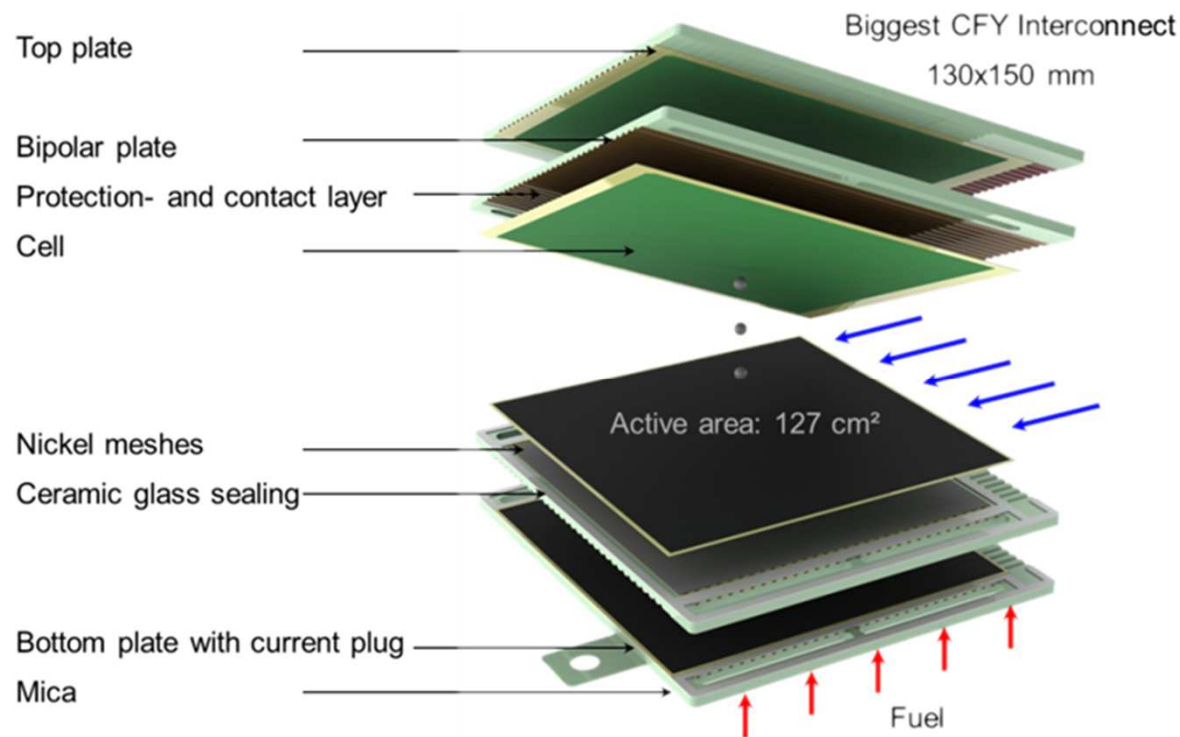
Activities of Plansee

- ESC stack concept deriving from forerunner projects with Siemens as baseline
- Development of suitable processes for the fabrication of SOFC specific powdermetallurgical alloys and processes for Cr-5(Fe1Y) stack interconnects
- (1) 1 kW Micro Combined Heat and Power (CHP) Hexis AG (CH)
- (2) Bloom Energy Systeme 100 / 200 kW

Overview

- Powdermetallurgical technology for SOFC stack components
- MK 351 stack: From Vision to reality
- Activities for mobile SOFC applications

Solid Oxide Fuel Cell (SOFC) Mk 351 CFY/ESC Stack components

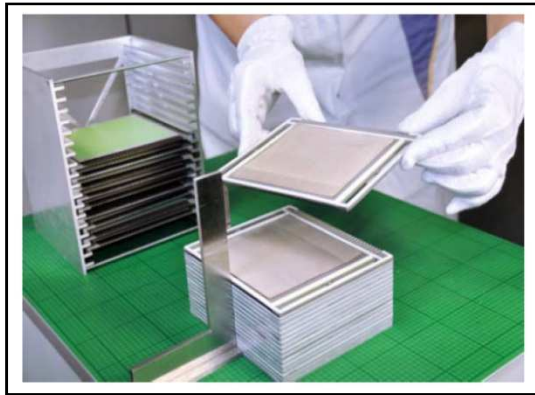


Interconnects and Cells

- The team Fraunhofer IKTS and Plansee are cooperating since more than a decade to advance the SOFC technology via a so-called CFY/ESC type stack called Mk351
- Cr-Fe-Y (CFY) interconnects (metal) and Electrolyte Supported Cells ESC (ceramic) and as main stack components

MK 351: From Vision to reality

Pilotline of SOFC stacks at Fraunhofer IKTS



Technology readiness

- Establishing of a robust and sustainable supply chain for all stack components
 - Interconnects
 - Electrolytes
 - Cells
 - Powder and pastes
 - Glas
- Establishing of a running pilot line for SOFC-Stacks at Fraunhofer IKTS in Dresden up to 1,000 Stacks x 1 kW p.a.

Mk 351 From Vision to reality

Performance data of Mk351 stack

| 30 Layer Stack | Properties |
|--------------------|---------------------------------|
| Power Output | ~ 900 W |
| Dimensions | 150 x 130 x 110 mm ³ |
| Weight | ~ 10 kg |
| Temperature | ~ 820 °C |
| Fuel | Hydro Carbons |
| Fuel Utilization | up to 85 % |
| Life Time (tested) | > 2 years |

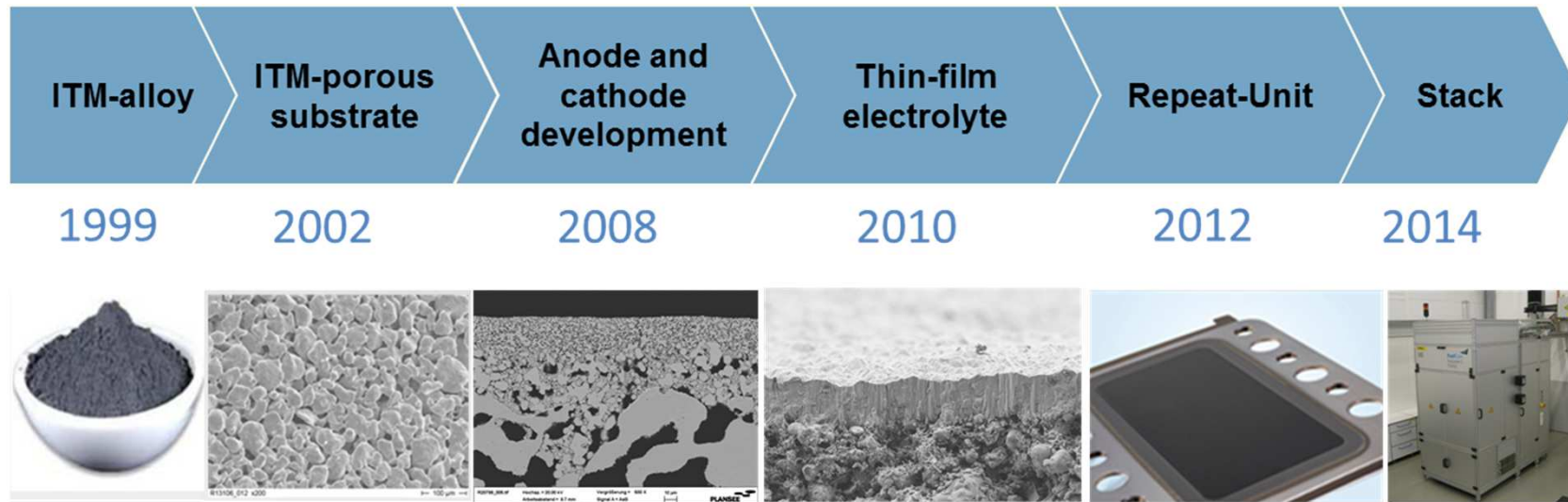
Mk 351 stack tests in Hot Box

- Stack tests are typically made in a custom designed and made hot box environment that means close to the system application
- Longtime power degradation with less than 0.7 % / 1,000 h
- Cyclic stability with less than < 0.8 % power degradation after 20 System cycles

Overview

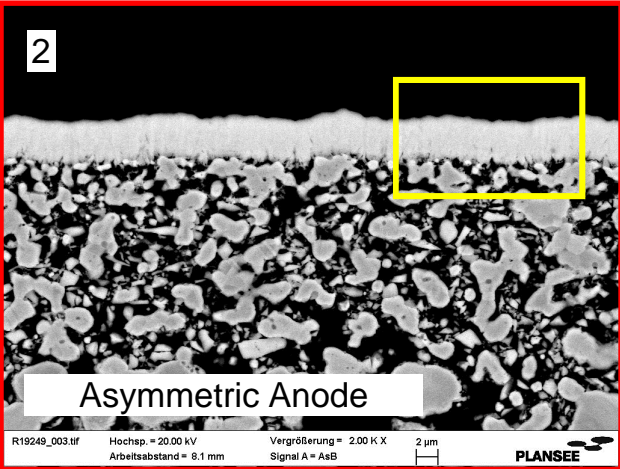
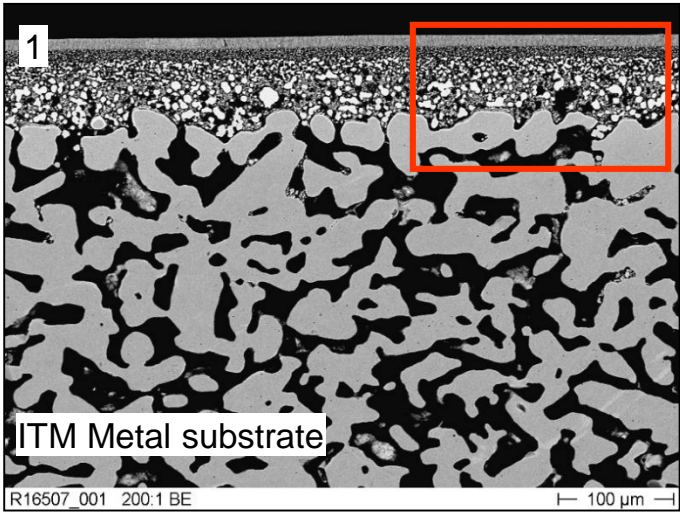
- Powdermetallurgical technology for SOFC stack components
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Metal Supported Cell (MSC) Chronology of Plansee's development



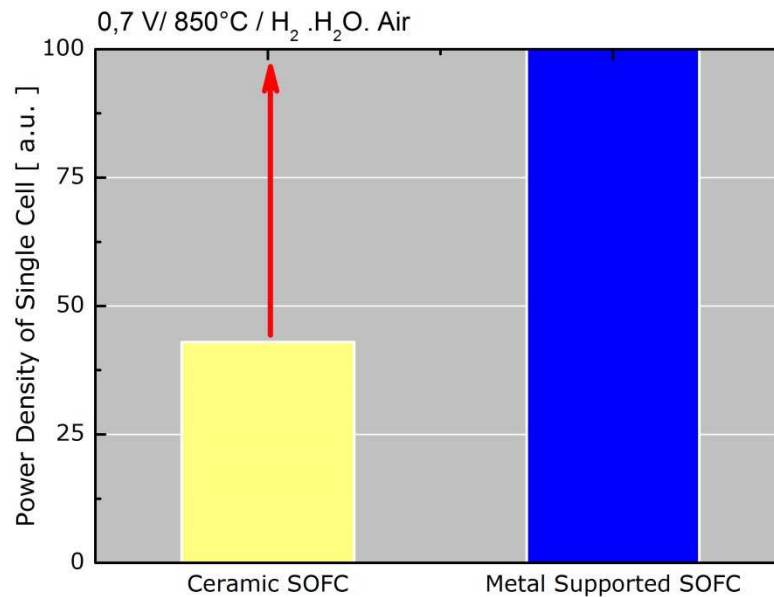
Metal Supported Cell (MSC) Critical-to-success features

Metal-Ceramic layer compound



Metal Supported Cell (MSC)

Status of achievements

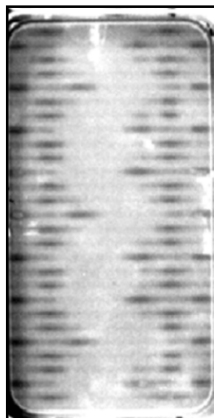
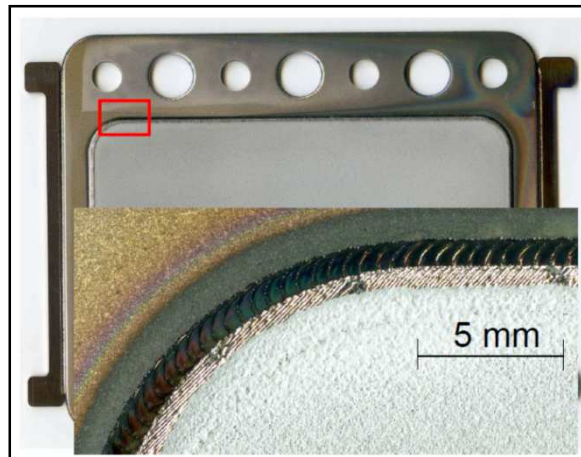


Summary

- Membrane quality (Electrolyte) of thin film MSC comparable to that one of full ceramic SOFC
- Proof of significant higher power density for the case of a MSC SOFC

Metal Supported Cell (MSC)

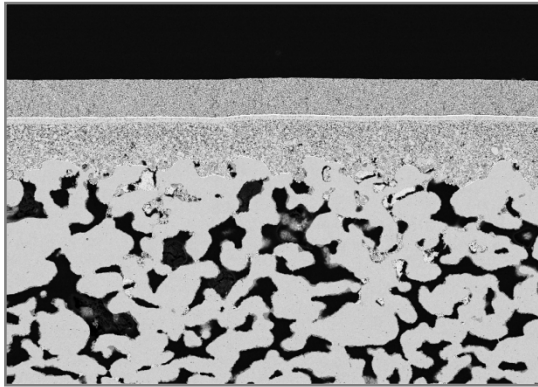
Status of achievements



Summary

- Membrane quality (Electrolyte) of thin film MSC comparable to that one of full ceramic SOFC
- Proof of significant higher power density for the case of a MSC SOFC
- Feasibility of robust stack concepts for fast heat-up and cool-down

Metal Supported Cell (MSC) From Cell to System



Plansee Metal Supported Cell



Advanced MSC Stack Concepts



Heavy Duty Vehicles Application

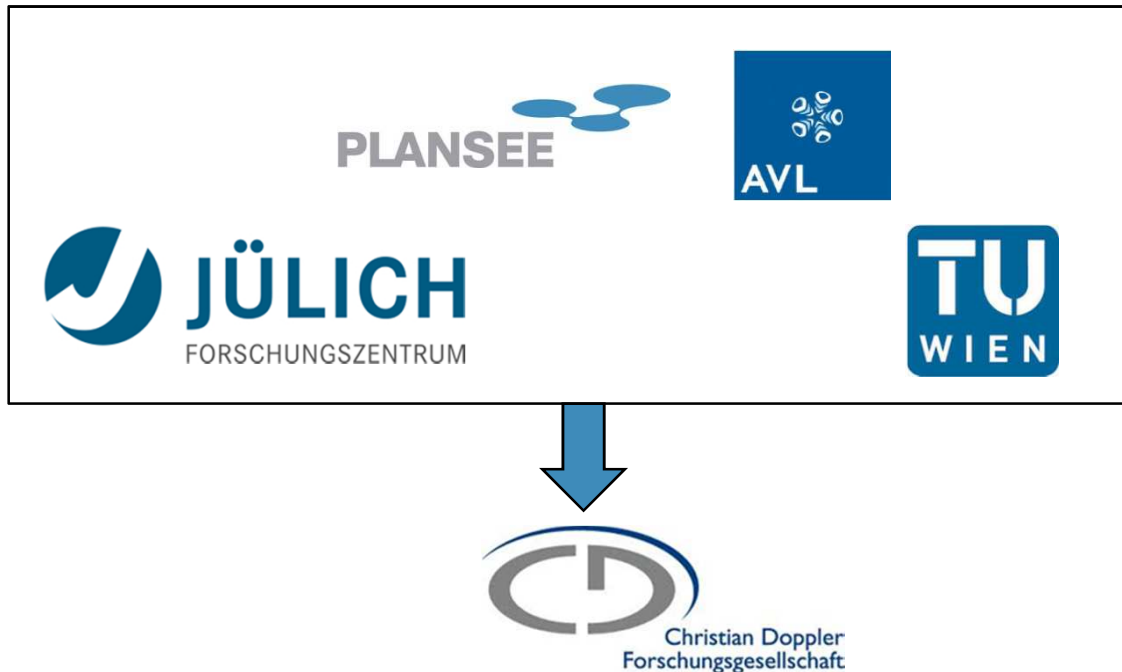


Testrig @ AVL (Austria)



AVL SOFC APU

Metal Supported Cell (MSC) Future work



Identification of improvements

- Higher quality requirements for fabrication of MSC
- Understanding of aging effects under long-term testing
- Development of MSC electrodes dealing with high sulphur diesel fuel
- Establishment of a multi-year research laboratory at RC Jülich (D) & University Vienna (A) to continue scientific R&D of MSC technology (supported by Christian-Doppler Society (Austria))



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