



Advent

High Temperature

Membrane Electrode Assemblies

sales@advent-energy.com

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About

Advent Technologies is involved in the production of innovative materials and systems for their application in renewable energy sources and has commercial activity related to fuel cells. The major effort focuses on **High Temperature PEM Fuel Cell systems** and the development of polymeric materials and **Membrane Electrode Assemblies** based on its proprietary technology.

Fuel cells offer efficiency, negligible emissions and simplicity. These characteristics, together with large market potential in the power generation sector, place fuel cells among the most compelling of the distributed generation technologies.

Advent Technologies is committed to bring the technology to the mass market, an enabling technology which will dominate the world fuel cells market.

Technology

The operation of **Polymer Electrolyte Membrane (PEM)** fuel cells at temperatures above 150°C offers very significant advantages which lead to compact and cost effective PEM fuel cells systems. Among others, the tolerance of the catalyst is increased allowing the use of reformed hydrogen with high CO content and the thermal management is easier comparing to the conventional PEM fuel cells.



L. Kifissias 44, Marousi Athens, GR15125 T: +30 210 637 8820 F: +30 210 637 8888

Research Laboratories: Patras Science Park, Rio Patras GR 26504 T: +30 2610 911 580-4 F: +30 2610 911 585

Advent North America: One Broadway 14th floor, Cambridge, MA 02142 T: +1-617- 682-3616, F: +1617 475 6045

Advent TPS[®] membrane characteristics

- Proprietary pyridine based aromatic polyether chemistry
- Excellent mechanical properties
- High thermal, chemical and oxidative stability
- High proton conductivity after being doped with phosphoric acid
- Easy to mass produce due to favourable membrane properties
- Low cost

Typical properties of Advent TPS[®] membrane

Properties	Value	Unit
Thickness	60-65	μm
Molecular weight (M_n) ¹	65000	-
T _g ²	250-255	°C
T _d (5% weight loss) ³	415	°C

¹Size Exclusion Chromatography (SEC) method (CHCl₃, PS standards)

²Dynamic Mechanical Analysis (DMA) method

³Thermogravimetric Analysis (TGA) method (under Ar)

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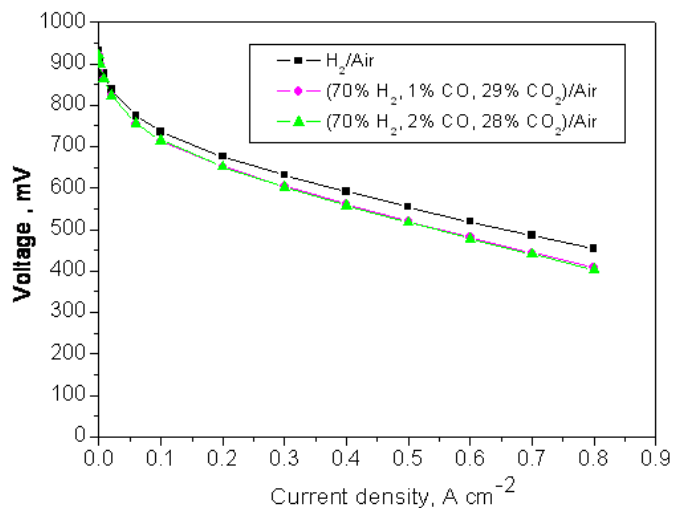
High Temperature Advent TPS® MEAs

Advent Technologies high temperature (150-200°C) MEA is based on pyridine type proprietary ADVENT TPS® polymer electrolytes. ADVENT TPS® technology is polybenzimidazole (PBI) free and less expensive than the competition, allows the use of fuels with high CO content and reduces the complexity and the cost of the final PEM fuel cell system.

Advent TPS® MEA characteristics

- Operational temperature 150-200°C
- Pyridine based aromatic polyether electrolyte
- High carbon monoxide tolerance
- Long term stability with small voltage drop
- Zero degradation under cycling operating conditions
- Endurance under differential pressure
- No need for humidified gases
- Low cost

Advent TPS® MEA performance at 180°C with reformate gas: High CO tolerance



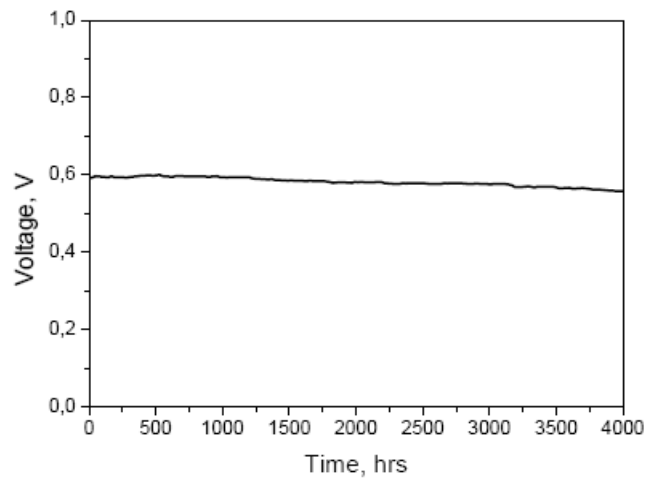
Ambient pressure
Feed: H₂/air
Anode: 1.2
Cathode: 2.0

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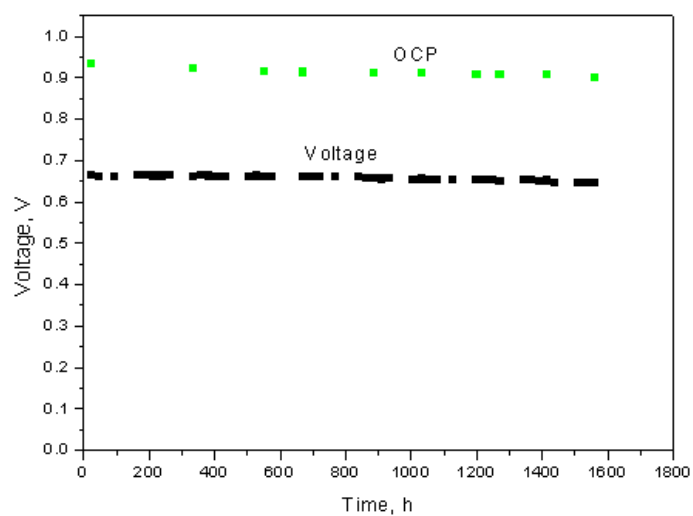
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**Operational stability – More than 4000 hrs of continuous operation verified so far
Degradation rate: 9 μ V/hr**



Current density: 0.2 A/cm²
 Temperature: 180°C
 Ambient pressure
 Feed: H₂/Air
 Anode: 1.2
 Cathode: 2.0

New Generation MEA – over 1500hrs with zero degradation



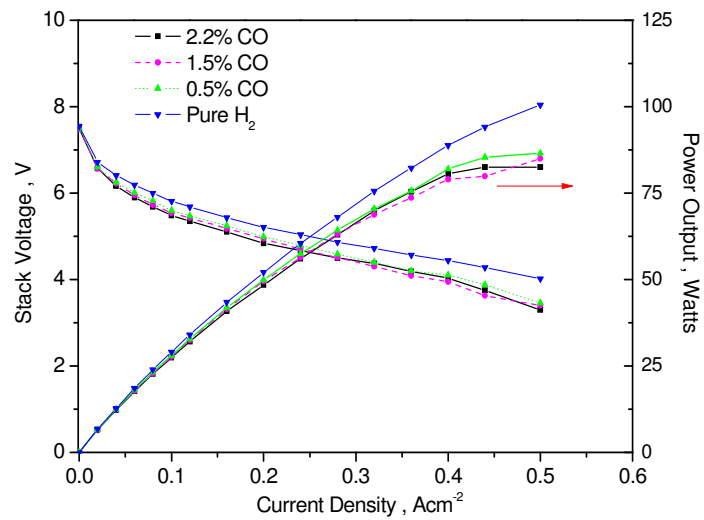
Current density: 0.2 A/cm²
 Temperature: 180°C
 Ambient pressure
 Feed: H₂/Air
 Anode: 1.2
 Cathode: 2.0

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Stack Data



Temperature: 170°C

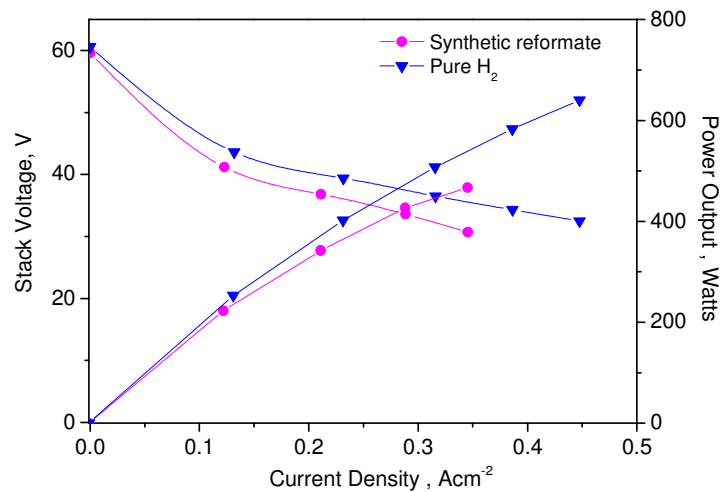
9-cell stack, 50cm²

Ambient pressure

Feed: H₂/Air, Reformate (1.7%CH₄, 21.7%CO₂, 74% H₂, d.p. 35°C)/Air

Anode: 1.3

Cathode: 2.0



Temperature: 160°C

65-cell stack, 50cm²

Ambient pressure

Feed: H₂/Air, Synthetic Reformate (75.8% H₂, 21.9% CO₂, 2.3 % CO)/Air

Anode: 1.2

Cathode: 2.0