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Prospect and Technical Challenges for Portable Fuel Cell Commercialization

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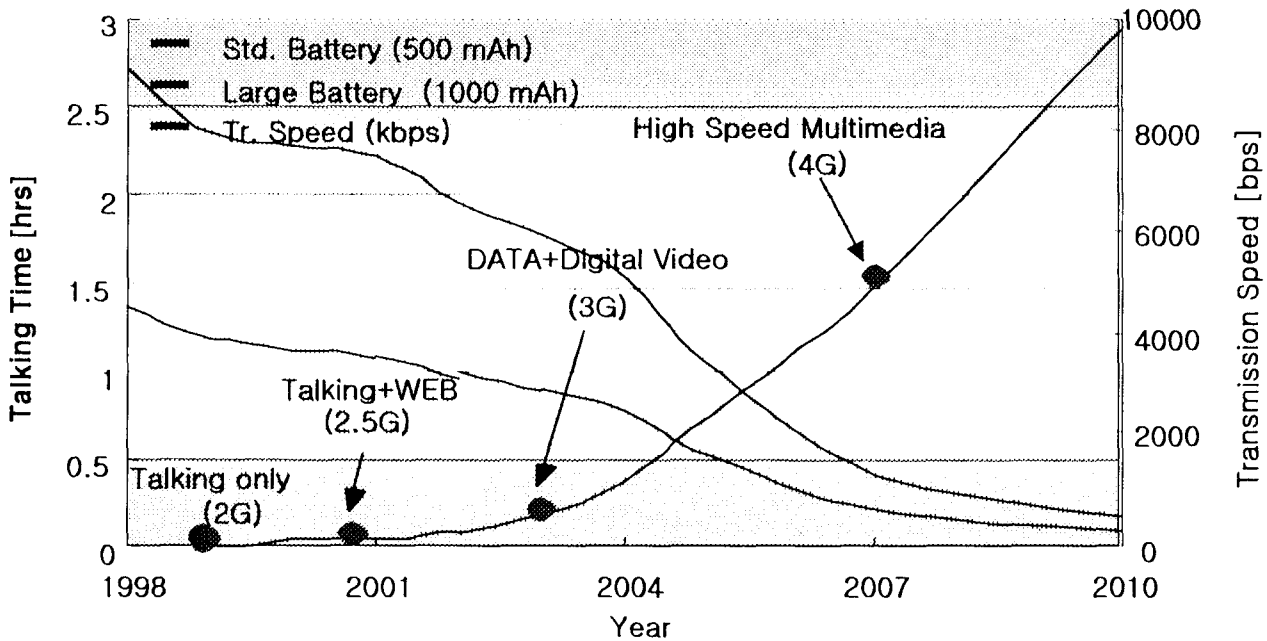
Outline

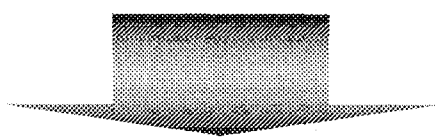
- Power Demands and Voice of Customers
- Fuel Cell Developers
- Core Technologies (MEA, Membrane and Cell Pack)
- Portable Power System including 100W Stack
- SAIT Portable Fuel Cells
- Future R&D

Power Demands of Next Generation Mobile Devices



Voices of Customers

1. Long time operating power
2. Quick Charging
3. High power and energy density
4. Safety
5. Small and light power



Fuel Cell

Energy Storage Device Technology Roadmap

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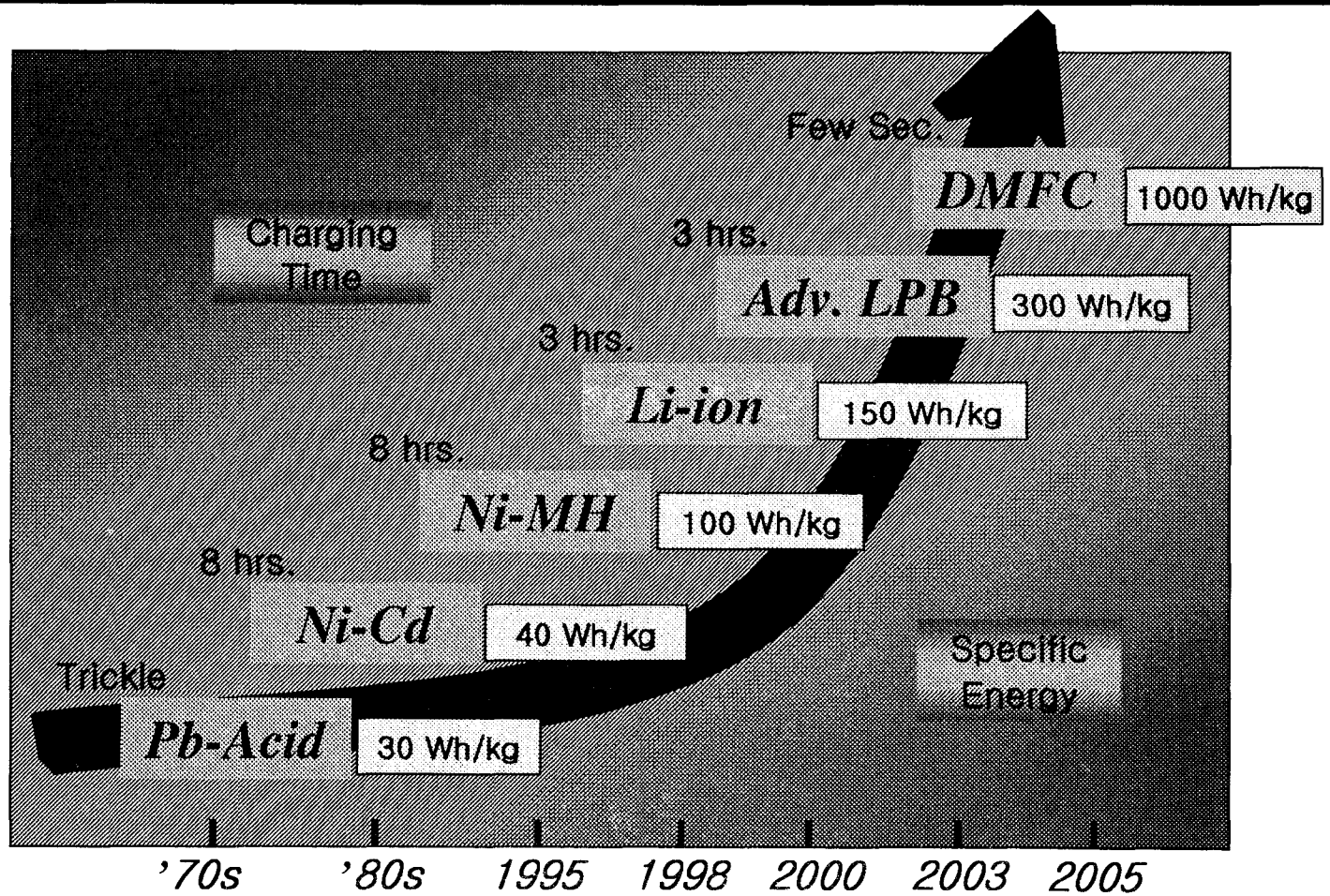

Fuel Cell Developers

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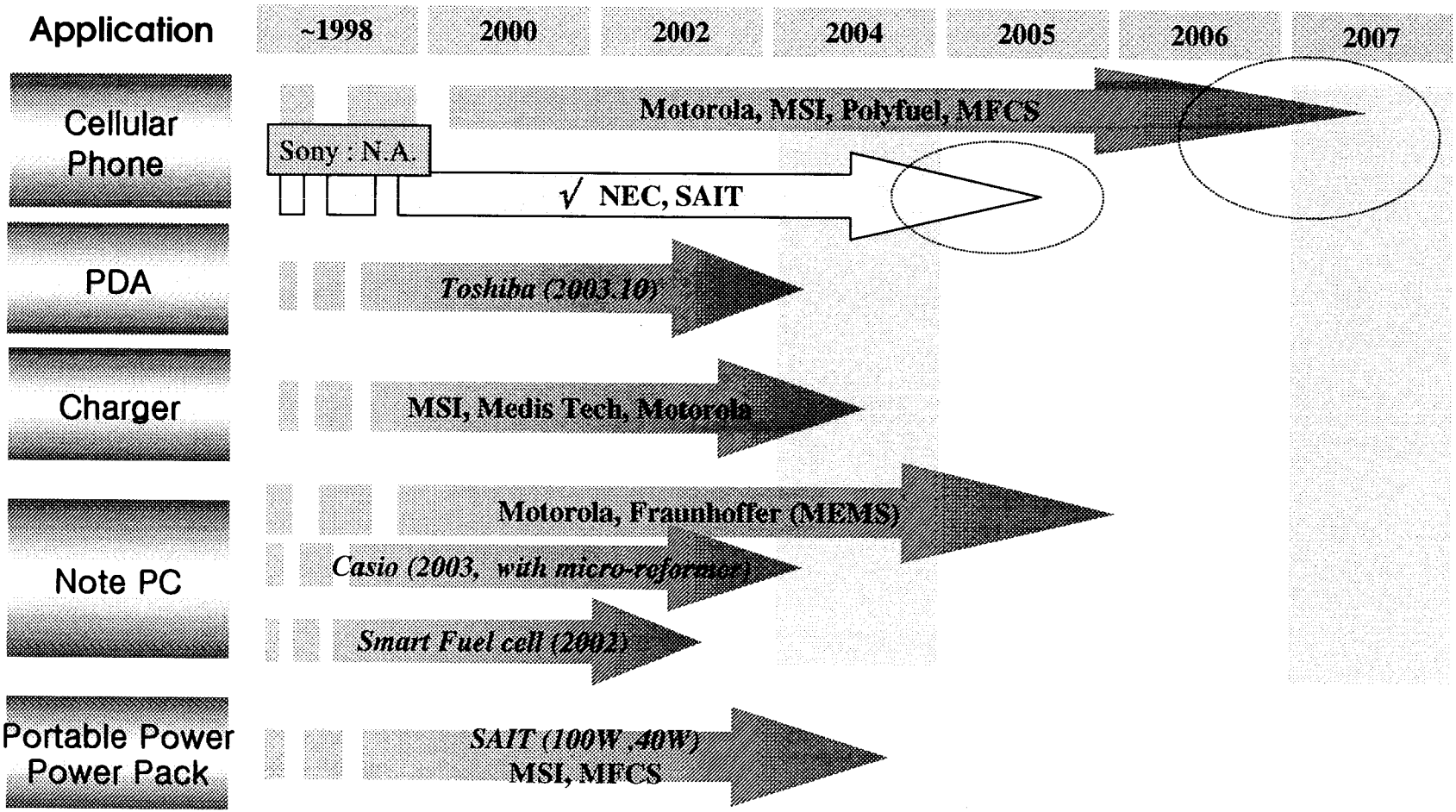
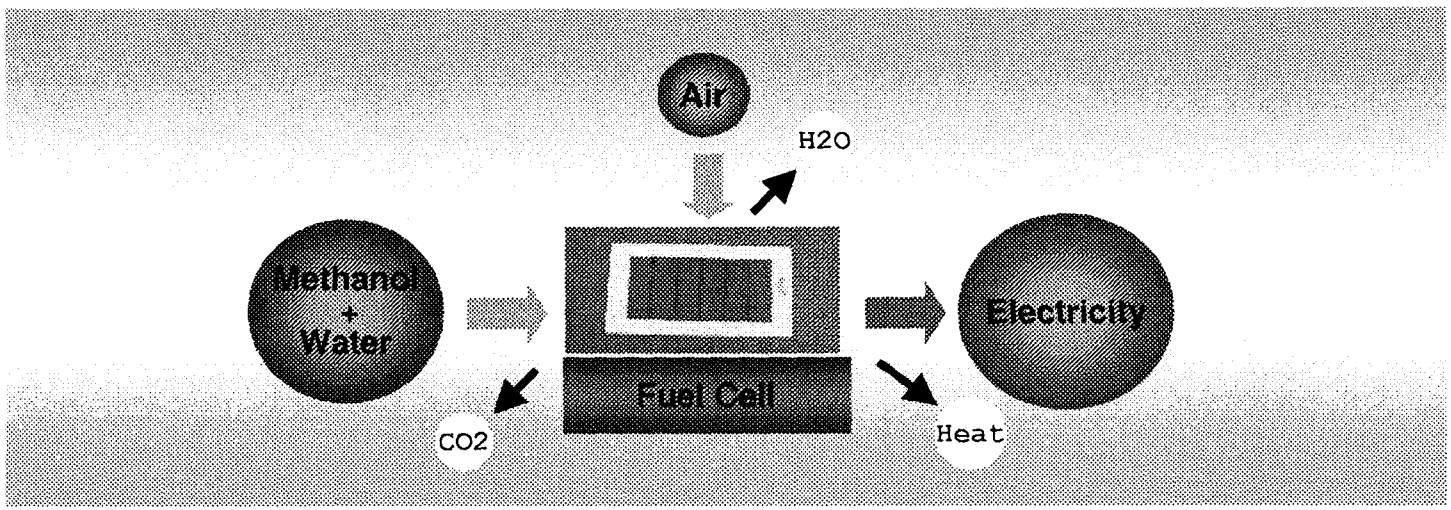


■ Portable DMFC Concept



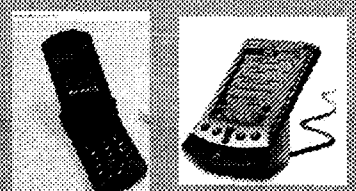
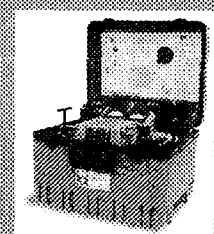
■ Electrochemical Reactions

$$CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$$

$$3/2O_2 + 6H^+ + 6e^- \rightarrow 3H_2O$$

$$CH_3OH + 3/2O_2 \rightarrow 2H_2O + CO_2 \ (E = 1.18V)$$

Category of Portable Fuel Cell

Power	< 5 W	5 ~ 50 W	100 ~ 500 W
Application	 Cellular Phone, PDA Digital Camera	 Laptop PC, Camcorder, Electric tools	 Military power, On-site power
Market	Large ←		→ Small
Technical Difficulty	Difficulty ←		→ Ease

Competitiveness to Rechargeable Batteries

Key Words

Fuel Efficiency

Energy Efficiency

Power Density

Convenience

Energy Density

Mass Production Process

Price

Core Technologies

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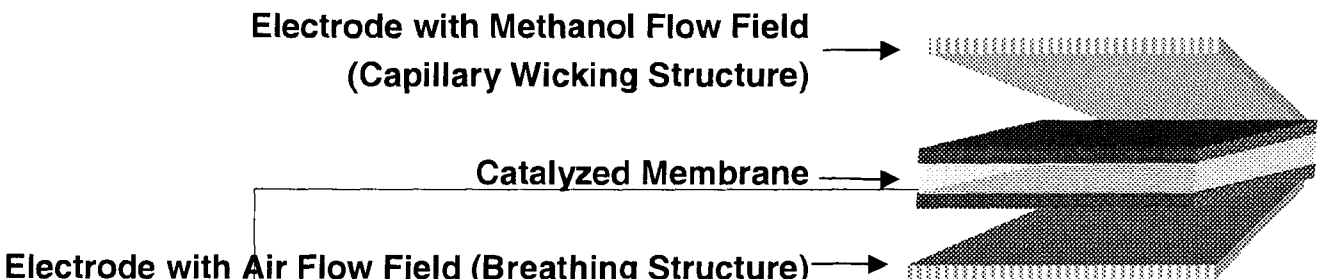
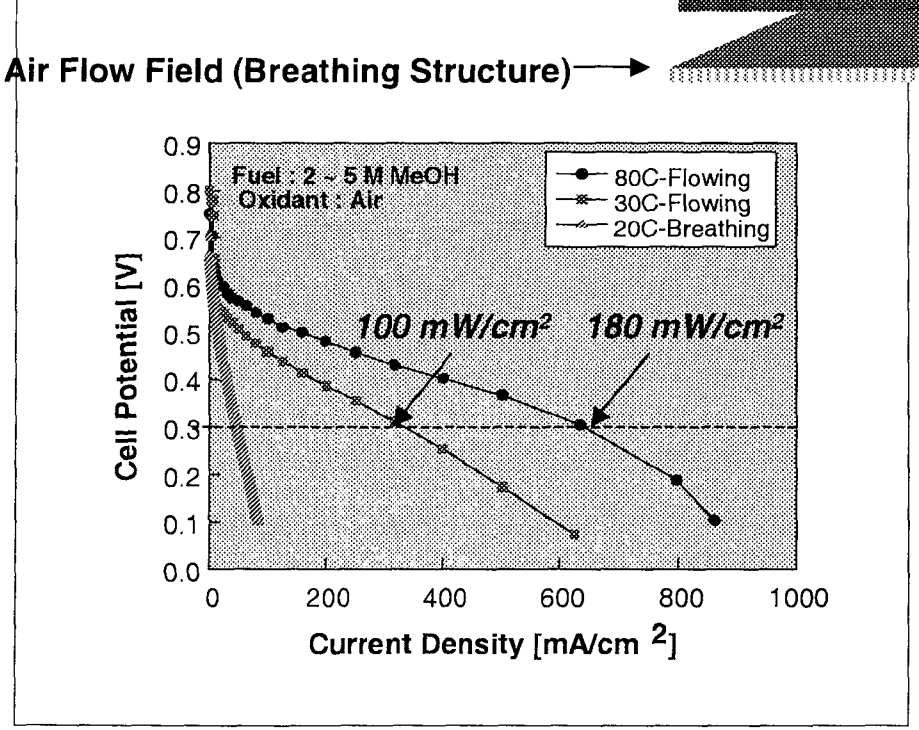
Core Technology	Technical Issues
MEA	· Catalyst Electrode Process · High Power Density MEA · Self Humidified (Water Management Electrode) · Air Breathing Diffusion Layer · CO Tolerant Catalyst · Catalyst Coating (Catalyzed Membrane)
Membrane	· High Proton Conductivity / Conductance · Chemical / Mechanical Stability · Low Cost · Low Methanol Cross-over
Cell Pack	· Thin & Light Bipolar Plate · Cell Pack Design · Ambient Temp./Ambient Pressrue Operation

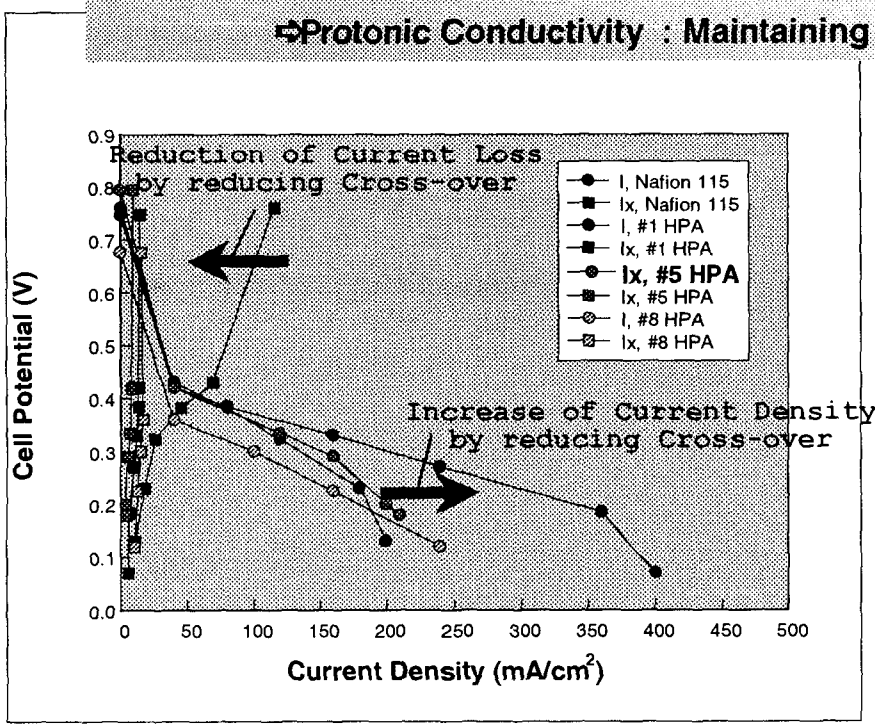
MEA Materials and Performance

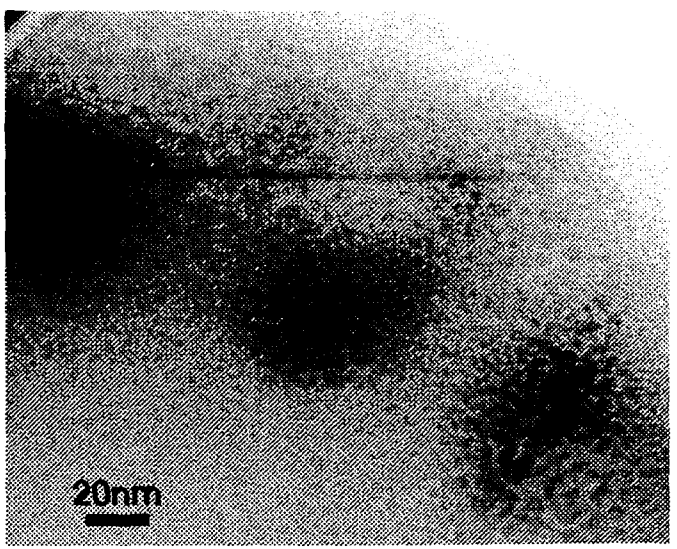




■ MeOH Cross-over Resistant PEM

- In-situ impregnation of Proton Conducting Inorganics
- Hybrid membrane by sol-gel process or hydrolysis with Matrix (Co-PTFS or Nafion)
  - ⇨Cross-over : 30 % vs. Nafion
  - ⇨Protonic Conductivity : Maintaining the same as Nafion (0.1 S/cm)





Cell Pack Design

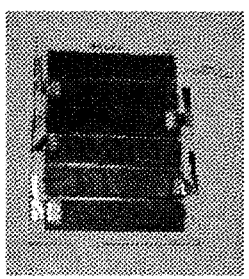
■ **2000 mW Cell Pack**

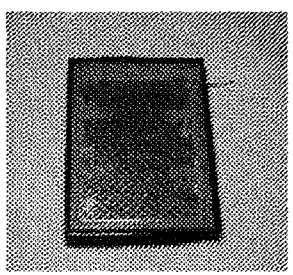
- **Single Embodiment of Current Collector & Fuel Supply Path**
- **High Density Electrode Arrangement**
- **CO_2 Removal Path Design**

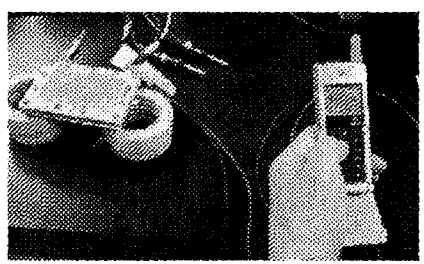
⇨**2000 mW (3.6 V - 570 mA)**

eg. 20 cc Fuel Storage : 4.8 Wh ; 1300 mAh ; 210 Wh/L ; 187 Wh/kg

⇨**Achievement of Power Requirement for Talking Mode**







Cell Pack Design and Performance

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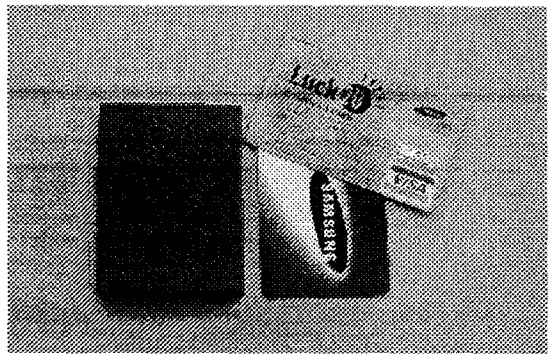
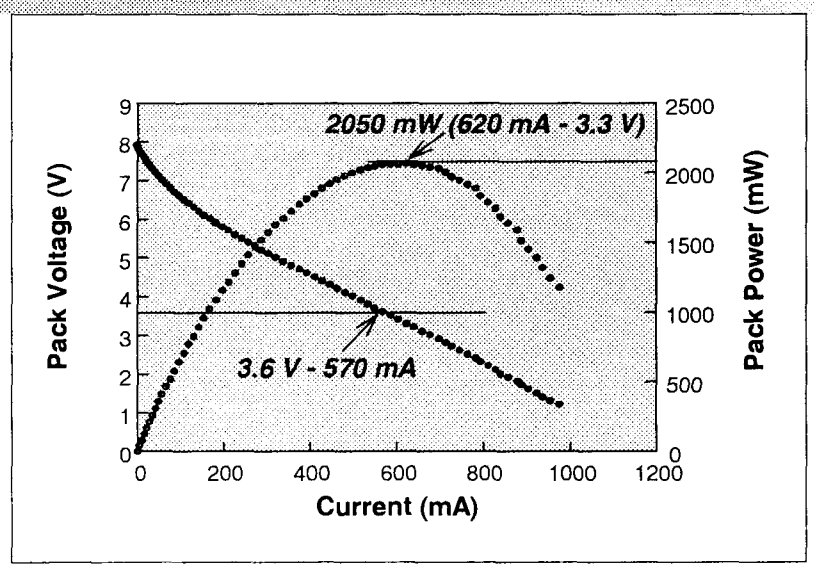
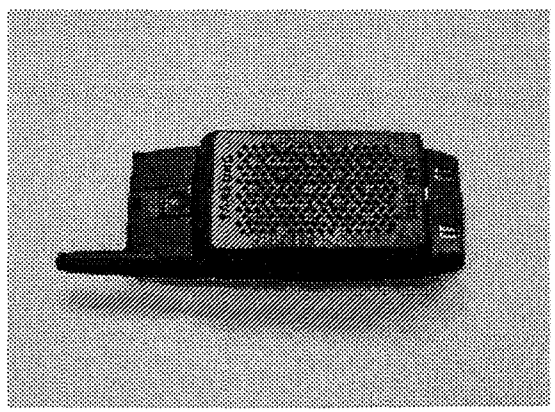
■ Power Performance

- 2000 mW (3.6 V - 570 mA)
  at Nominal Power Density : 32 mW/cm²
- 2600 mW (3.6 V - 720 mA)
  at Maximum Power Density : 50 mW/cm²







100 W Stack for Portable Power System

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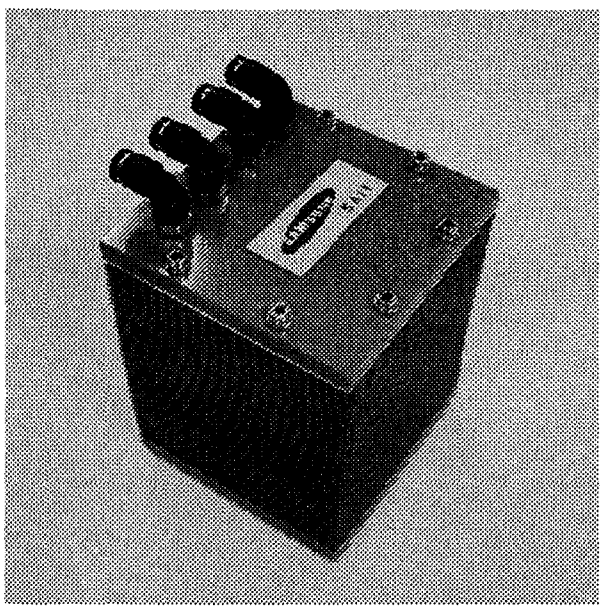
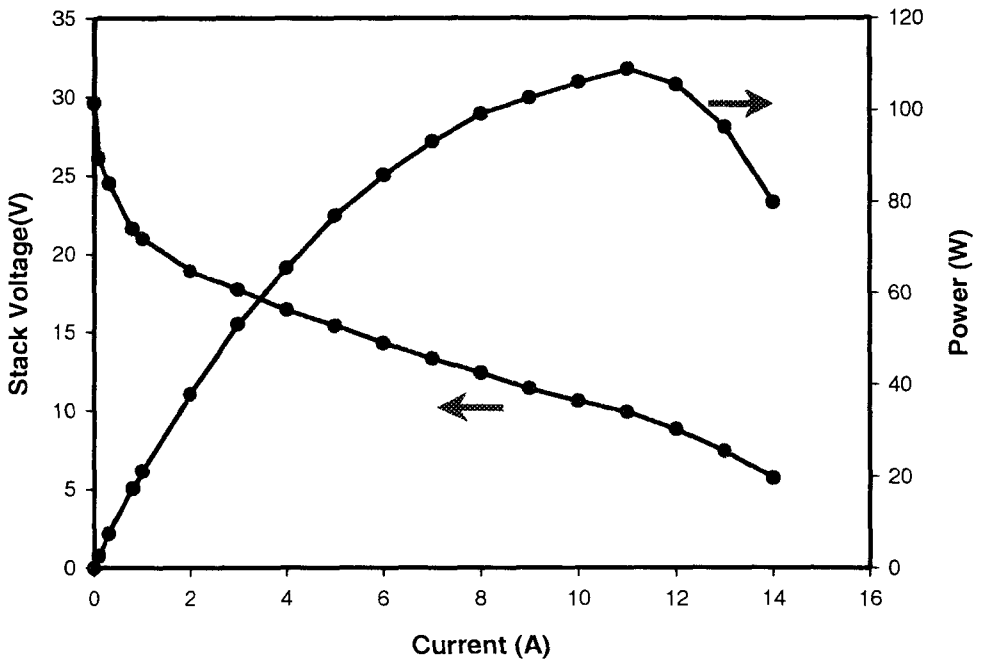
- Power: 100 W (9.0 A @ 11.4 V, max. 110 W)
- Low pressure drop



Cell Number : 40 ea.
Active Area : 38 cm^2 per Cell
Dimension: 10 cm*10 cm*12.6 cm
Weight: 1.6 kg



Operating Condition : MeOH/Air, 40°C
(stoichiometric flow rate=1.5)

Operation of DMFC System

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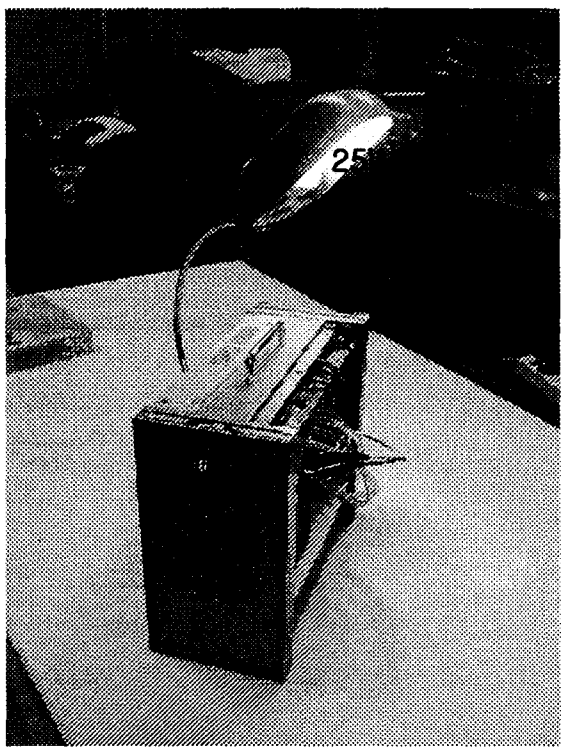
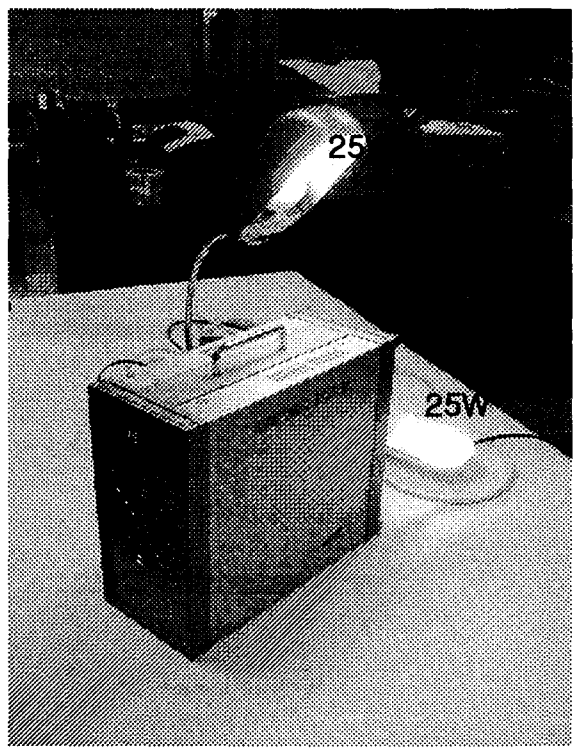
- Auto Controlled DMFC System (One Switch On System , 1.5 L Fuel Tank)
- Total 120W : Hybrid with 20W Ni-Cd Battery
- Power Output : AC 220V (75Wh at 2M MeOH / 1200Wh at 2M with MeOH Sensor)





SAIT Portable Fuel Cells

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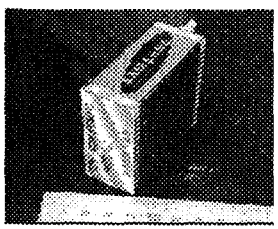
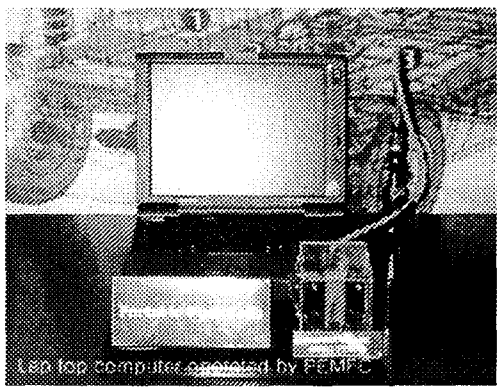
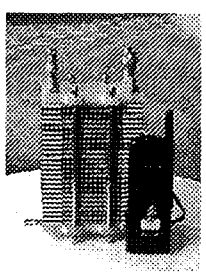
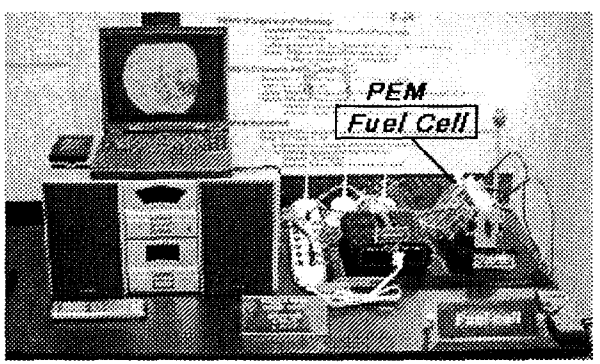
PEMFC

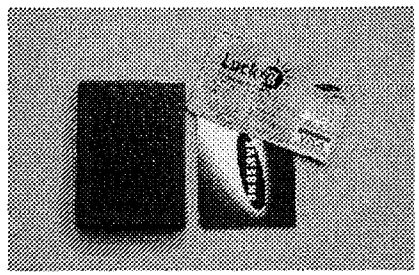


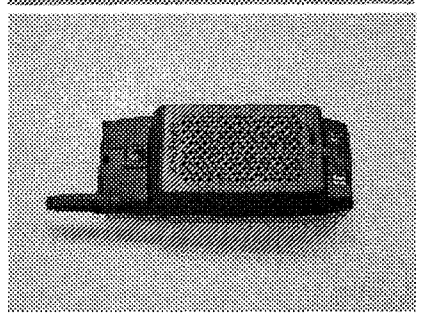






DMFC





Technical Requirements for Delivering DMFC to Consumer's Hands

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1. MEA having tripled power density
2. Membrane of maintaining the same protonic conductivity and near 0% cross-over when 10M or higher concentration of methanol fueling
3. Electrode and system design for effective dissipation of by-product such as H_2O, CO_2 and heat
4. Cost reduction & mass production process development

Further R&D

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Materials

Cathode Catalyst

Diffusion Electrode

Hybrid Membrane

Components

Methanol Flow Field

Air Breathing Structure

Micro System

Efficiency

Cost

Endurance

Mass Production

System

Circuit Design / Converting

Pack Design Optimization

Fuel Supply System

Hybrid with Other Power Sources

Life Cycle