
아연공기전지의 개발현황 및 전망

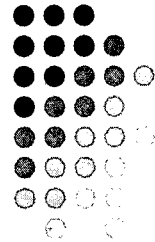
박 정 식 연구소장
(성남전자공업(주) 연구소)

아연공기전지의 개발현황 및 전망

[Zinc/Air Fuel Cell]

2004년 11월 11일

성남전자공업(주) 연구소
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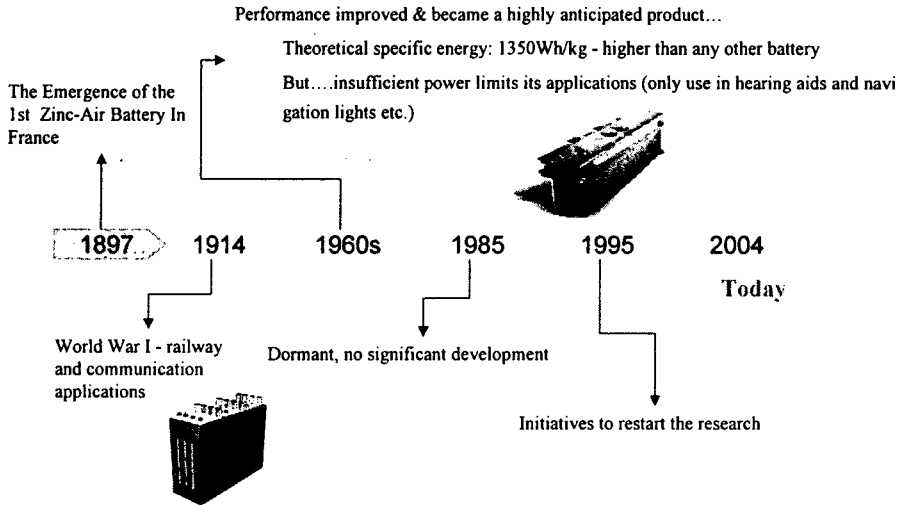
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 - 산업동향 및 전망, 업체 분석
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Introduction

Brief history

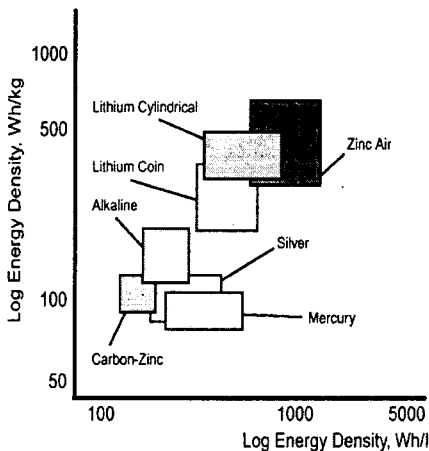


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Introduction

특징



Comparison of the energy storage capability of various primary battery systems.

- 고 안전성 전지
 - > 안전한 수계 전해질 사용
 - > 보호회로가 불필요
- 환경친화성 전지
 - > 지구상에 가장 풍부한 아연과 공기 사용
- 저가형 전지
 - > 저가의 아연과 무비용의 공기 사용
 - > 전지구조가 간단
- 고 에너지 밀도형 전지
 - > 이론에너지밀도 $\approx 1,000 \text{Wh/l}$ (Zn base)

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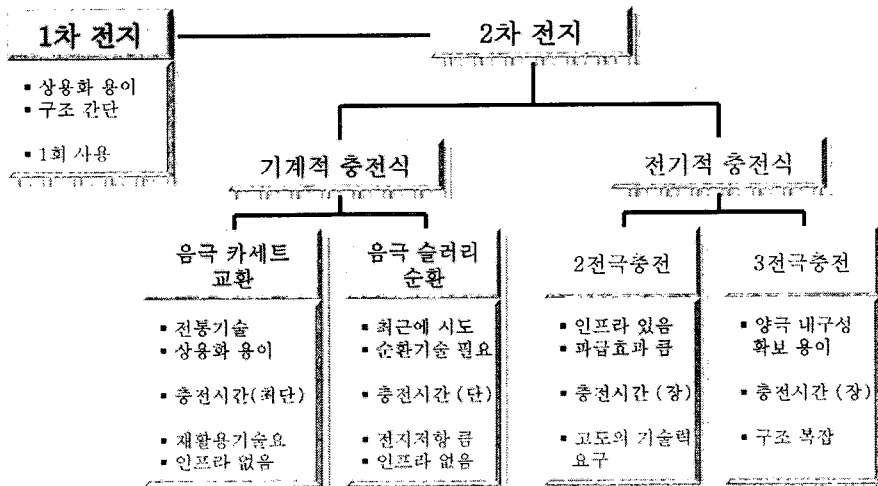
Introduction

- **Advantage**
 - High energy density
 - Flat discharge voltage
 - Long shelf life (dry storage)
 - No major ecological problems
 - Relatively low cost
 - Capacity independent of load and temperature when working within normal operating range
- **Disadvantage**
 - Not completely independent of environmental conditions (Drying-out limited shelf life once exposed to air, Flooding may limited power output)
 - Limited power output
 - Limited operating temperature range
 - Hydrogen evolution from anode corrosion
 - Carbonation of alkali electrolyte



Introduction

Battery type

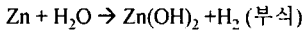
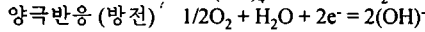
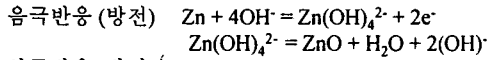
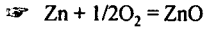
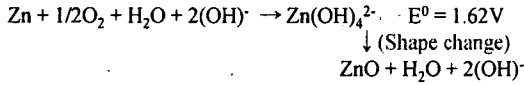




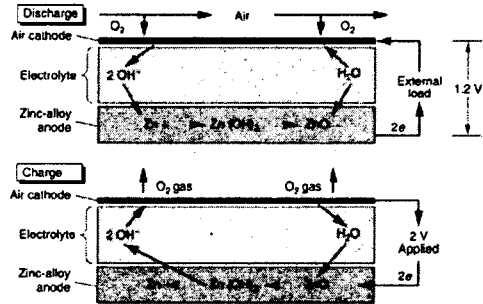
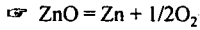
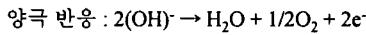
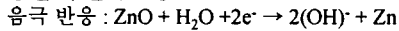
Introduction

Basic concept

● 방전 시 전체 반응



● 충전 시 전체 반응

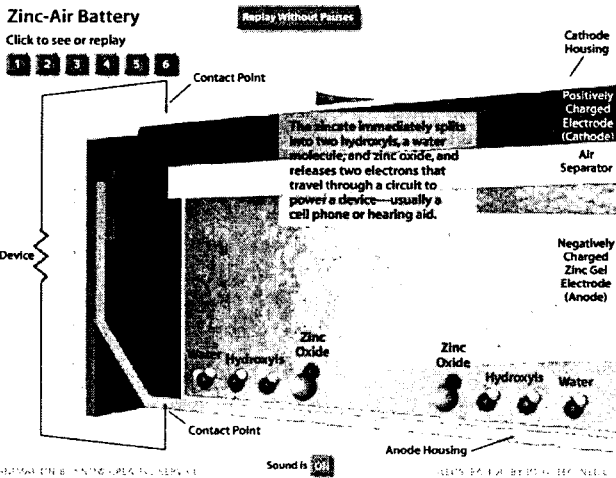


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Introduction

Basic concept



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Introduction

Structure

Cathode Material

- MnO₂
- PTFE suspension
- Carbon black / Conducting agent
- Ni mesh
- Non-woven fabric

Anode Material

- Zinc powder
- Poly acrylic acid
- KOH electrolyte
- Separator

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Technology

Process

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Technology

Air cathode

Gas diffusion electrode



Current collector

- 구성 및 역할 : Metal mesh (Ni or Cu), 집전체

Gas Diffusion Layer

- 구성 : Carbon(Graphite) + PTFE
- 역할 : 수분 침투방지, 공기 유로제공, 전도 path 제공

Catalyst Layer

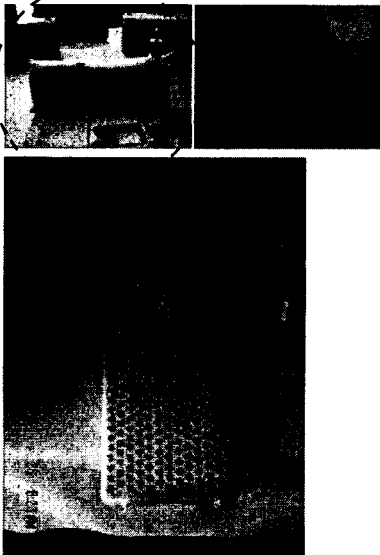
- 구성 : Carbon(Graphite) + PTFE + Catalyst
- 역할 :
 - ✓ Carbon(Graphite) : 촉매반응의 site 제공
 - ✓ Catalyst : O₂ reduction/evolution 반응 촉진
 - Pt, Pt/Ru, Perovskite

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Technology

Zinc anode



Zinc Powder

- Particle size, Surface area
- Zinc or Zinc Alloy
 - ✓ Zinc/Zinc-In/Ga/Bi Alloy

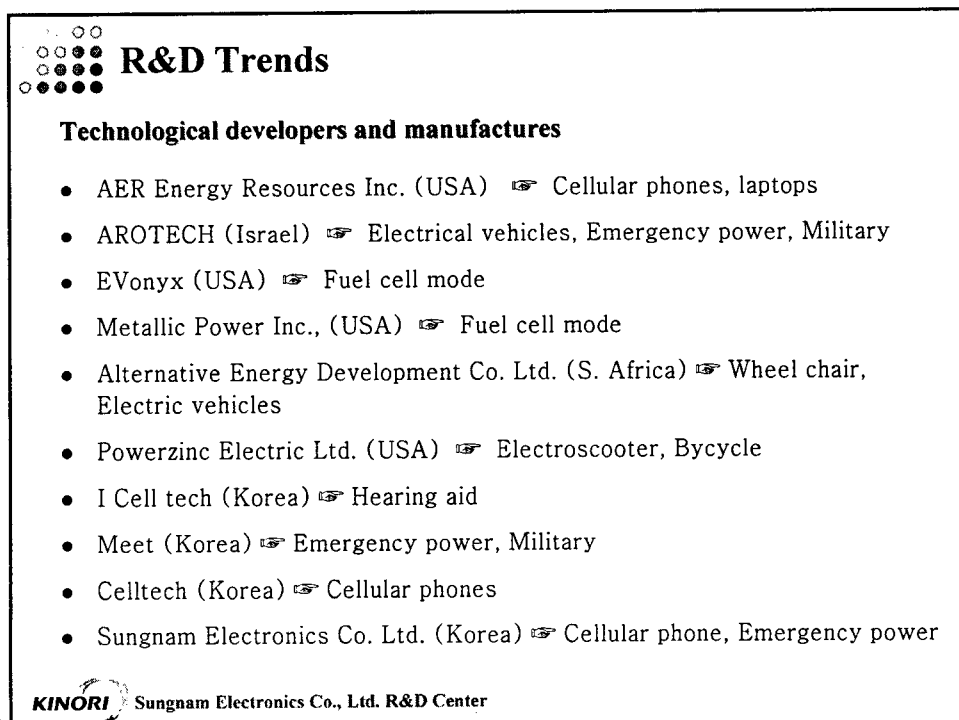
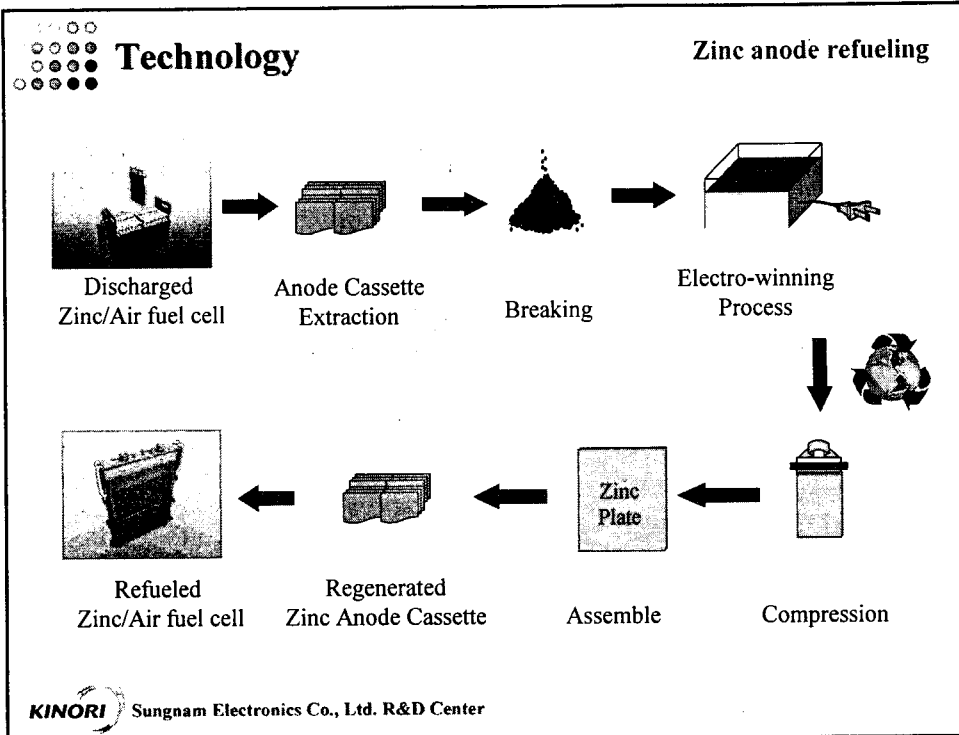
Anode Corrosion

- $Zn + 2H_2O \rightarrow Zn(OH)_2 + H_2$
- 해결방법 :
 - ✓ Surfactant, PbO 등의 첨가제
 - ✓ 음극 자체를 Zn Alloy
 - ✓ Corrosion Inhibitor

Anode Dendrite

Zn (충전 후) ↔ ZnO (방전 후)
: 체적변화 및 수지성장

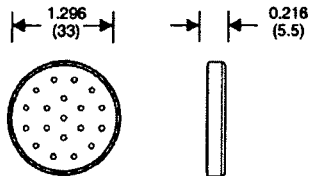
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R&D Trends

AER research



INTERACTIVE

Electrical

- | | |
|----------------------------|----------------------------------|
| Open Circuit Voltage: | 1.4 V |
| Nominal Operating Voltage: | 1.2 - 0.8 V (design using 1.1 V) |
| Cutoff Voltage: | 0.75 V |
| Capacity: | 4.0 Ah at 0.25 A (25 °C) |
| Energy: | 4.7 Wh at 0.25 A (25 °C) |
| Pulse Capability: | 2.0 A for 100 ms |
| Energy Density: | 335 A Wh/Kg |
| | 1000 Wh/l |

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R&D Trends

AROTECH

Disposable Power

[Motorola Star FAC series]

- Capacity: 3300 mAh
- Weight : 79g
- Talk time : 6-16 hr
- standby time : 80-350 hr



Disposable Instant Power Charger

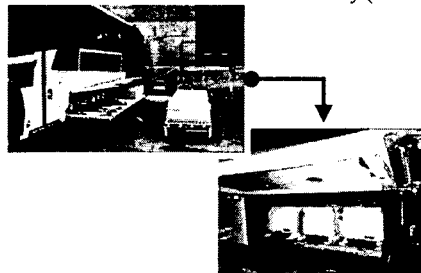


Power Cartridge Universal to all phone and PDA models

- Capacity : 3300 mAh
- Dimensions : 52 x 68 x 13 mm
- Weight : 76g
- Operating Voltage : 3.6V

Electric vehicle

- Passenger : 40 seat & 37 standing
- Weight : 17,955kg
- Propulsion System : Zn/Air(312kWh)
+ NiCd battery (22kWh)

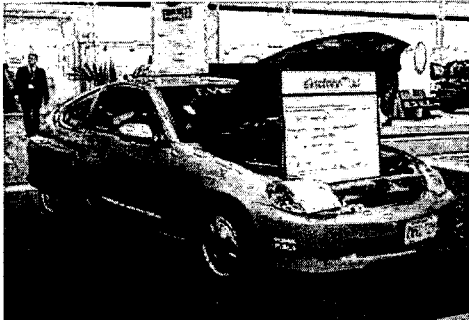


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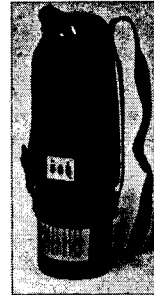
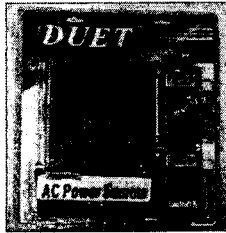
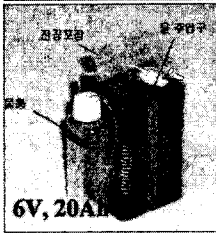


R&D Trends

EVonyx



EVonyx Insight
Honda Insight converted to run on Zinc Air fuel cell.



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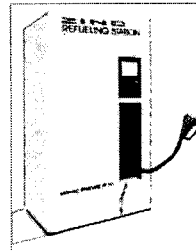
R&D Trends

Metallic Power

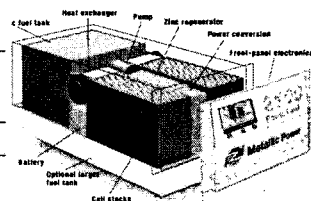


Metallic Power will provide reliable, clean, extended backup power for computing, communications, and controls. Based on a unique zinc fuel cell technology, Metallic Power will assure hours of continuous operation for mission-critical applications. The system will incorporate an electrically-regenerative fuel cell that provides DC functionality similar to a battery or battery-generator combination.

The basic configuration consists of zinc fuel cells, a zinc "fuel tank" and a zinc regenerator that automatically recycles the fuel once utility power is restored. The regeneration process is conceptually similar to the recharging cycle of a battery. The entire system is housed in a single, small, complete package. Zinc fuel can be electrically recycled, eliminating the need for an ongoing fuel supply required by other fuel cells or engine generators.



Feature	Function	Benefit
Zinc/Air Technology	<ul style="list-style-type: none"> Wide temperature tolerance No hydrocarbon emissions Accurate fuel gauge and product monitoring Quiet operation No compressed gasses 	<ul style="list-style-type: none"> Saves HVAC costs Use where generators can't go Indicates accurate predictable backup time Welcome near offices, residences, and hospitals
Recycled Fuel	<ul style="list-style-type: none"> Zinc fuel is electrically regenerated Zinc and electrolyte are recyclable Eliminates fuel contracts/delivery 	<ul style="list-style-type: none"> No manual refueling required Environmentally friendly, eliminates waste Eliminates logistics and hassles
High Specific Energy	<ul style="list-style-type: none"> Approximately half the installed weight of lead acid batteries 	<ul style="list-style-type: none"> Easier, lower-cost roof mounting
Flexibility	<ul style="list-style-type: none"> Can be placed in parallel Indoor/outdoor capable 	<ul style="list-style-type: none"> Higher power or longer runtime Flexible, fits where needed, saves space, saves money



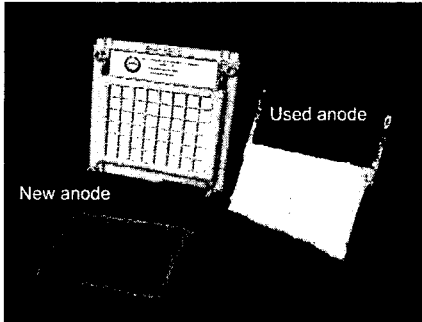
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R&D Trends



ALTERNATIVE ENERGY DEVELOPMENT CORPORATION Ltd.



AEDC zinc-air fuel cell with anodes shown separate. The grey anode is new (new zinc), the white anode is used (zinc oxide).

- Dimension : 18 x 17,5 x 2,5 cm, Weight : 460g
- Capacity : 100Ah

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R&D Trends

POWERZINC

Electric Bicycle



Power Source	Capacity	Weight	Range
Zinc Air Fuel Cell	70Ah	11kg	200 km per refuel
Lead-acid Battery	17 Ah	12kg	50 km per charge
Lead-acid Battery	12Ah	8kg	30 km per charge

Electric Motorcycles and Electric Scooters



Lead-Acid Battery
Total 62 lbs 120 Wh
US\$203 / 2 batteries
→ 31 miles (50 km)

NiMH Battery
Total 63 lbs 960 Wh
US\$465 / 2 batteries
→ 38 miles (60 km)

1x DQFC-24-3200 (36lbs), 3270 Wh, US\$345

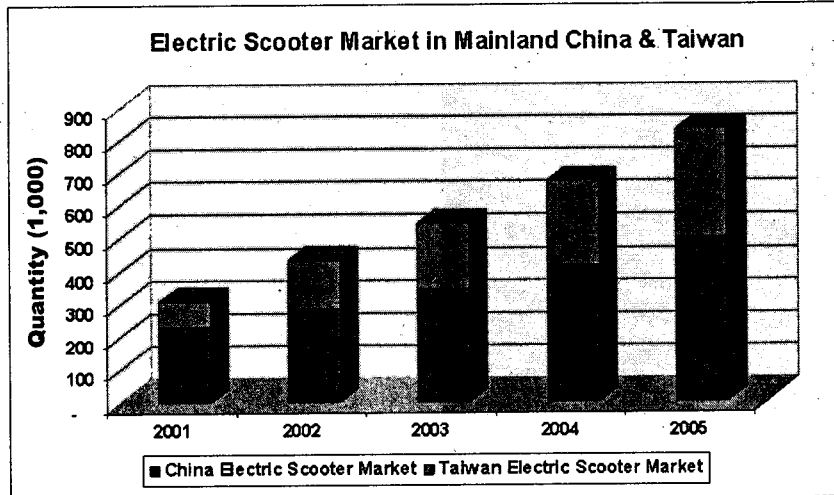
→ 131 miles (210 km)

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R&D Trends

POWERZINC

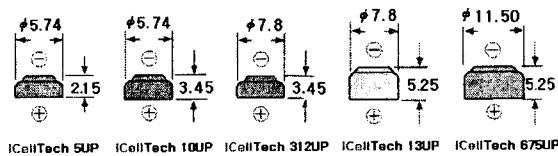


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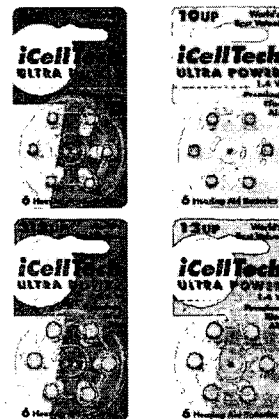


R&D Trends

iCellTech



Type	JIS Tape	Height		Diameter		Weight	Voltage	Typical Capacity (mAh)	
		mm	Inch	mm	Inch				
5UP	PR521	2.15	0.085	5.74	0.226	0.20	0.0004	1.4	35
10UP	PR536	3.45	0.136	5.74	0.226	0.33	0.0007	1.4	82
312UP	PR41	3.45	0.136	7.80	0.307	0.54	0.0012	1.4	160
13UP	PR46	5.25	0.209	7.80	0.307	0.86	0.0019	1.4	285
675UP	PR44	5.25	0.207	11.50	0.453	1.85	0.004	1.4	620

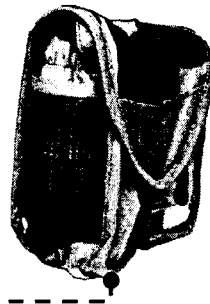


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R&D Trends

Metalcell Series [Capacity 50Ah]



Expanded



Collapsed

Decreasing the storage volume.
Increasing the toughness.

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R&D Trends

Cell Tech



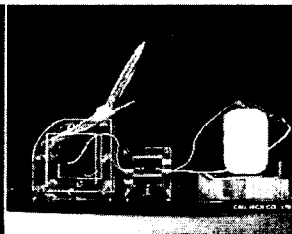
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CELL TECH CO., LTD.



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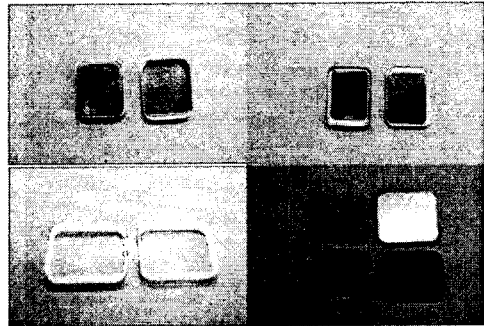
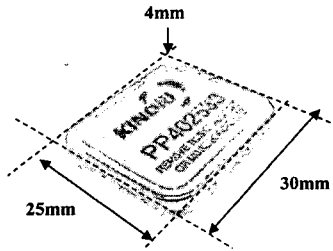
CELL TECH CO., LTD.

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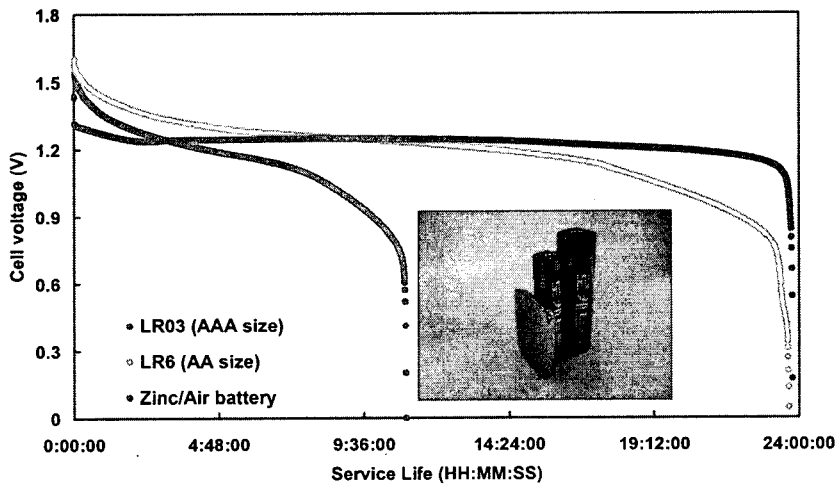
PP402530

- Discharge capacity : 2,400mAh @ 100mA
- Operating Temp. : -20° C to +60° C
- Weight : 9.8 grams per cell
- Self discharge rate : 3%/year (with seal tape)
- Safety : Does not contain mercury, cadmium, lead or other dangerous materials.

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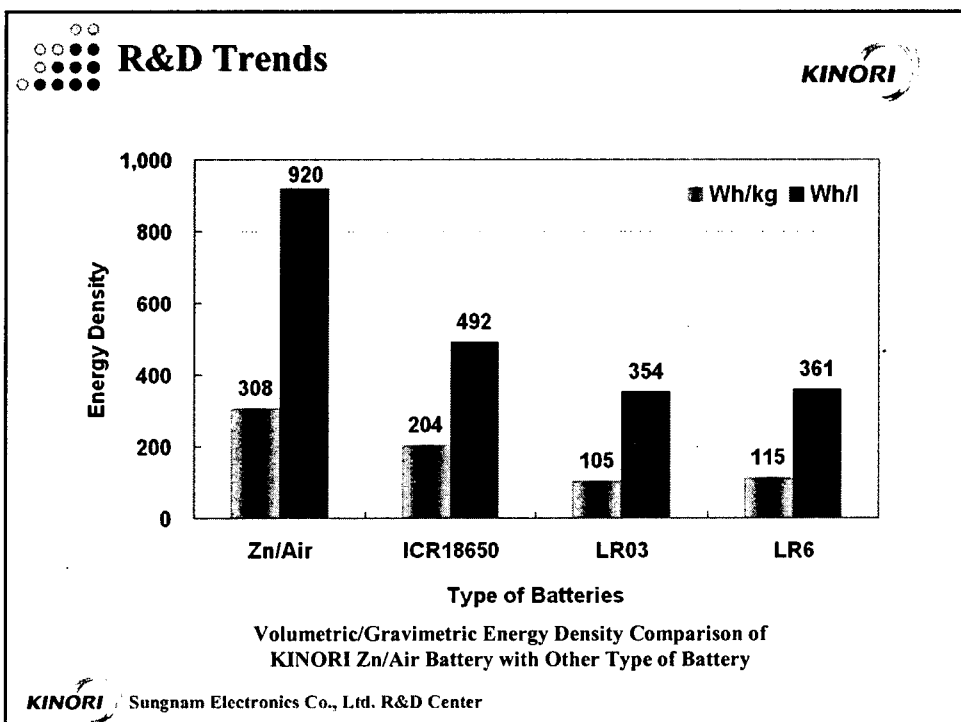
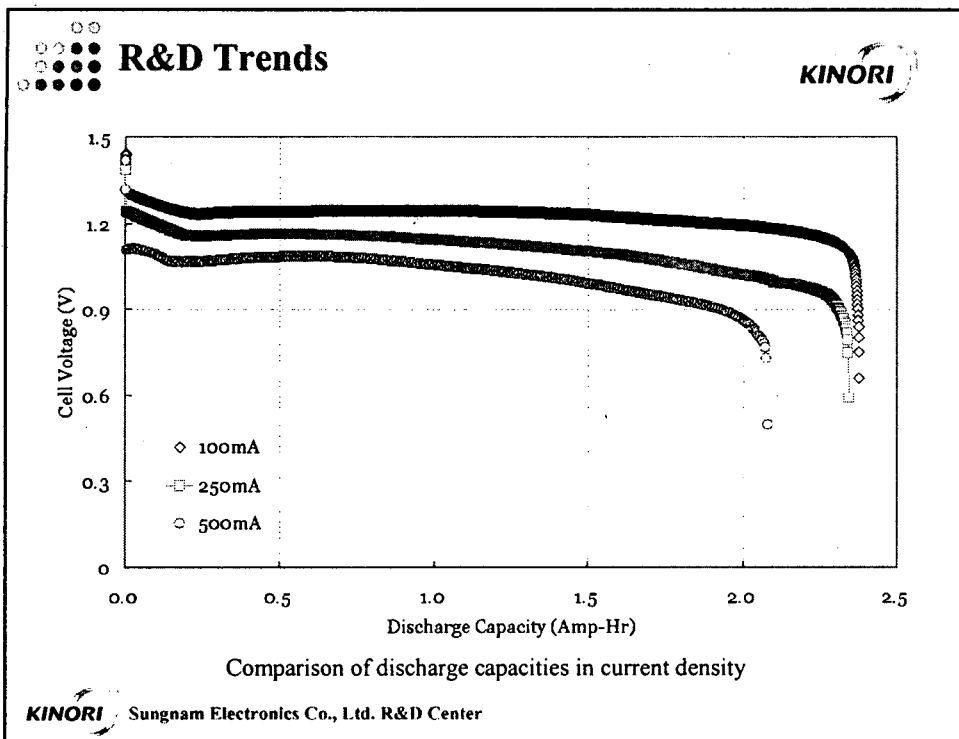


R&D Trends



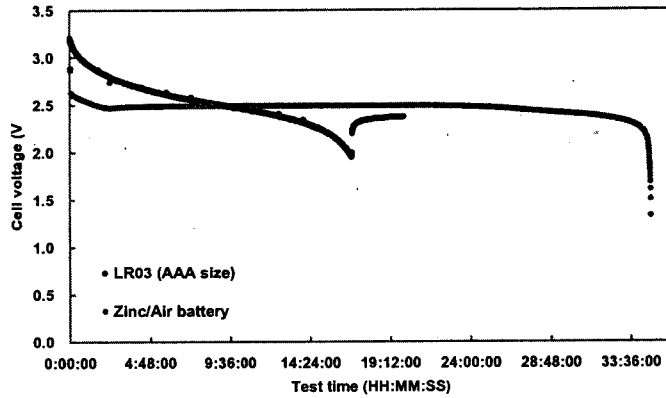
Comparison of Service Life (@ 0.1A)

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R&D Trends

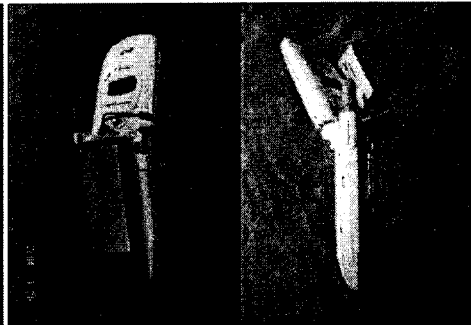
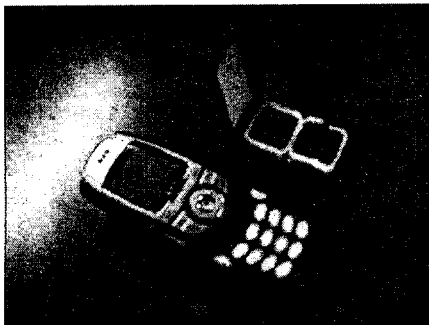


	LR03 (AAA size) * 2EA	Zinc/Air Battery * 2EA	Advantage of zinc/air battery
Weight (g)	23.8	19.6	82%
Volume (cm ³)	7.1	6.0	85%
Usable time (HH:MM:SS)	16:54:00	34:37:00	208%

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R&D Trends



■ 휴대용 전화기 주전원

- PP402530 X 4Cell
- Operating voltage : 4.8V
- Nominal capacity : 2,400mAh

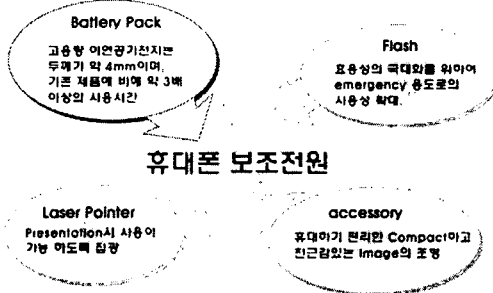
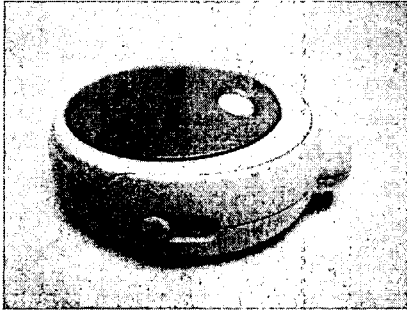
■ 휴대용 전화기 보조 전원

- PP402530 X 3Cell
- Operating voltage : 3.6V
- Nominal capacity : 2,400mAh
- With lithium ion battery

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R&D Trends



Emergency power for mobile phone

- Size : PP402530 * 3cell
- Capacity : 2.4Ah
- Voltage : 3.0~3.6V
- Hybrid lithium ion battery

- 고용량 이연공기전지를 적용하여 기존 알카라인전지 보다 compact 하고 휴대 및 사용하기 편리한 보조전원 장치
- 충전환경이 주어지지 않는 곳 또는 외부에서 장시간 사용 될 필요가 있는 환경에서도 사용이 가능한 높은 에너지 밀도를 갖는 보조전원으로 활용

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Summary

• Main conventional applications

- Mobile application : Cellular phones, Laptops
- Traction : Wheel chairs, Electrical vehicles, Cleaning machines
- Stationary : Power blocks, Remote area power supply (RAPS)
- Military : Pilot phase of a variety of confidential application
- Fuel cells : Mechanical recharge mode
- Starter : Only possible as hybrid with a high energy storage source like supercapacitor



• Present R&D action

- Cell for high cycle uses
- Solid or fixed electrolyte
- kW power modules with high energy densities



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Summary

■ Zinc/Air primary battery

- ① Hearing aid 용 등이 상용화 구축 완료되어 있으며, 수은 전지 대체 전원으로 사용되고 있음.
- ② 휴대용정보통신기기 및 휴대 장치의 전원 및 보조전원으로 사용확대가 요구되며, 군용 장비의 전원으로 확대되고 있음.

■ Rechargeable Zinc/Air battery

- ① 소형 장비 및 휴대이동통신용기기의 전원으로 접근 시도
- ② Stationary plant, EV 등의 적용을 위한 지속적인 R&D 투자가 요구됨.

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**Thank you for your
attention.**

CONTACT POINT

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