A High Temperature Electrochemical Energy Storage System Based on Sodium Beta"-Alumina Solid Electrolyte (BASE) DOE Contract Number: DE-PS26-05NT42470-1A

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Na-S Batterv

NGK's 500 kW Battery

Positive Attributes of Na-S Battery

- Demonstrated life > 8 yrs in 500 kW size 1)
- 2) Largest demonstration - 8 MW
- 3) > 90% roundtrip efficiency
- 5 times peak power capacity 4)
- 5) Thermal cycling
- Projected low cost 6)

Limitations of Na-S Battery

- 1) Low volumetric power density due to tubular design
- 2) Graphite felt necessary in the cathode
- 3) Battery fails in open circuit mode

Project Objectives

- To synthesize thin, strong, planar BASE by patented vapor phase process 1)
- 2) To synthesize tubular BASE by patented vapor phase process
- 3) To evaluate prospective salt-based cathodes
- To conduct electrochemical tests 4)
- 5) To fabricate planar cells, subject them to charge-discharge cycles
- To thermally cycle cells from operating temperature to room temperature 6)
- 7) To construct a planar 10 cell stack of Na/BASE/ZnCl₂



Na-β"-Alumina Structure

Na-B"-Alumina 1)

- Na-ion conductivity: ~0.3 S/cm at 300°C
- 2) Excellent stability in oxidizing-reducing atmospheres 3)
 - Low cost

4)

- Conventional BASE attacked by water
- 5) Vapor phase BASE - resistant to moisture attack



Time of Dav

Tubular Cell Test



BASE Fabrication/characterization: (1) Tubular BASE by die-pressing, slip-casting, sintering, vapor phase conversion, (2) Planar BASE by tape-casting, sintering, vapor phase conversion, (3) XRD, SEM, conductivity, (4) Boiling in water for water resistance

Planar Cell Design, Construction, Preliminary Testing

Cell Reactions Discharge: $2Na + ZnCl_2 \rightarrow 2NaCl + Zn$ Charge: $2NaCl + Zn \rightarrow ZnCl_2 + 2Na$





Cycling:

- 1) Steel end plates with cavities for cathode and anode
- 2) NaCl + ZnCl₂ + Zn + steel wool in cathode
- 3) Steel wool in anode
- 4) BASE disc with copper gaskets
- 5) Testing at 350°C
- 6) Charge discharge and freeze thaw cycles

Future Scope

- 1) A 10 cell stack
- 2) Full electrochemical characterization
- 3) SOFC-Battery hybrid unit



SOFC-Battery Hybrid



Planar cell:



