CERAMATEC®

TOMORROW'S CERAMIC SYSTEMS

# Sodium Battery Technology

October 2010

# Who We Are

CoorsTek
Amazing Solutions.

*100 Years of Ceramic Manufacturing Experience*

DEW ENGINEERING & DEVELOPMENT

- *Integrated Composite Armor Solutions*
- *Canadian Military Contractor*

CoorsTek ARMOR SOLUTIONS

- *Integrated Composite Armor Solutions*

SELECTION TECHNOLOGIES™

C5 medicalwerks

- *Implantable Ceramic Components and Assemblies For Medical Applications*

CERAMATEC TOMORROW'S CERAMIC SYSTEMS

- *Advanced Materials and Electrochemical Technologies*

EmiSense smart sensors – clean emissions

- *Enabling Sensor Emission Technology For Clean Combustion*

# Ceramatec/CoorsTek

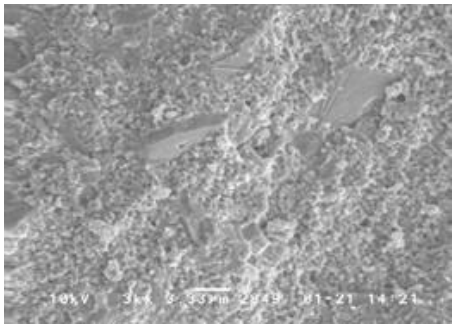
- Ceramatec was founded on sodium-sulfur ceramic separator technology and has 33 years experience developing new battery chemistries
- CoorsTek is largest U.S. based manufacturer of high-technology ceramic materials and systems

Ceramatec + CoorsTek =

R&D + Scale-up + Large Scale Manufacturing

# Ceramatec/CoorsTek

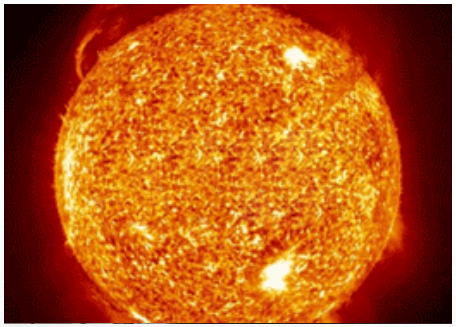
**Vertical integration ensures quality, capacity and the expertise to lead the industry in material development …**



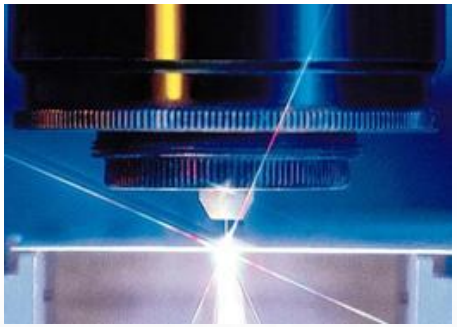
Materials Design →

Material Preparation →

Forming



Sintering →



Machining →

Finishing & Cleaning

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# Industrial Mobilization


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# PV Power Today

Nothing

Energy from gas turbines

Consumer


*Utilities must switch to spinning reserves*

# PV Power Tomorrow

$e^-$


NaSelect™

Rechargeable Sodium
NaSICON Battery
20 kWh, Ambient Temperature

$e^-$ (as needed)

Consumer


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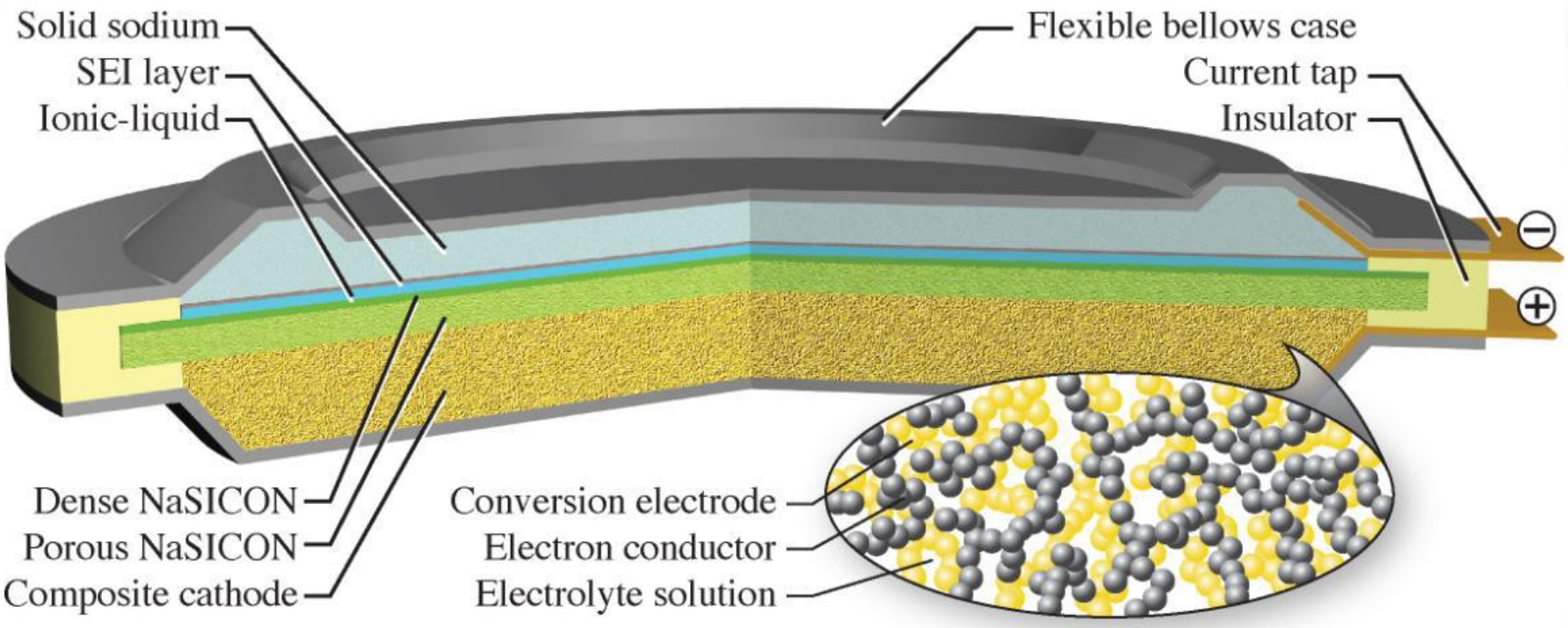
# Battery Performance Requirements

- Battery must be able to charge/discharge at least once per day for 10+ years (~4,000 cycles)
  - Exhibit very low capacity fade
  - Require very little maintenance
- Incremental delivered cost less than $0.025/kWh (or $100/kWh installed capital cost)

# Ambient Temp Na-Battery




Compliments: R.J. Kee, Colorado School of Mines (2010)

# Advantages of Proposed Sodium Battery

- **Breakthrough technology**:
  - Solid primary electrolyte NaSICON ceramic separator
  - Ion-selective for passage of sodium ions
  - Allows for room temperature operation (aqueous/non-aqueous)
- **Sodium based**:
  - Sodium available everywhere
  - No reliance on imported lithium
- **Scalable**:
  - Ideal for multi GWh-scale production
  - Brings advanced battery manufacturing back to the US