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**Materials & Systems Research, Inc., 5395 W 700 S, Salt Lake City, UT 84104**

## Company Introduction

### History

- ❖ Founded in 1990 by Dr. Dinesh K. Shetty and Dr. Anil V. Virkar
- ❖ Currently 11 employees including 5 PhDs
- ❖ 10,000 ft<sup>2</sup> research facility in Salt Lake City, Utah



### Current Major Areas of R&D

- ❖ Batteries and fuel cells
- ❖ Hydrogen production
- ❖ Sensor element development
- ❖ Thermally-stable, high-strength materials

## Key Personnel

- ❖ Anil V. Virkar (Ph.D. Materials Science/Eng.)
- ❖ Neill Weber (Ph.D. Chemistry)
- ❖ Greg Tao (Ph.D. Mechanical Engineering)
- ❖ Joonho Koh (Ph.D. Chemical Engineering)



Dr. N. Weber and Dr. J. Kummer who invented Na-S battery in 1970s



Dr. Weber, now at MSRI

## Overall Project Description

### Goal

Develop advanced Na battery technology for enhanced safety, reduced fabrication cost, and high-power performance

### Approach

- ❑ Innovative cell design using stronger structural materials
- ❑ Reduction of the fabrication cost using a simple and reliable processing technique
- ❑ Fast prototyping utilizing MSRI's experience of Na battery research and development

## Key Milestones To Achieve

### Phase-I (October 2012 to June 2013)

- ❑ Demonstration of the advanced cell design concept by demonstrating area specific resistance (ASR) lower than 0.5  $\Omega \cdot \text{cm}^2$
- ❑ Demonstration of strength over 200 MPa

### Phase-II (July 2013 to September 2015)

- ❑ Demonstrate single cells (30-150 Ah), battery module (100-200 W), and a kW battery pack
- ❑ Demonstrate >140 Wh/kg, >1000 cycles, and >80% efficiency
- ❑ Show a commercialization path toward the cost target <\$100/kWh

## Status of the Na Batteries

### Conventional Na-S Battery

- Successfully commercialized by NGK
- High specific energy >100 Wh/kg
- No self-discharge and long cycle life >5000

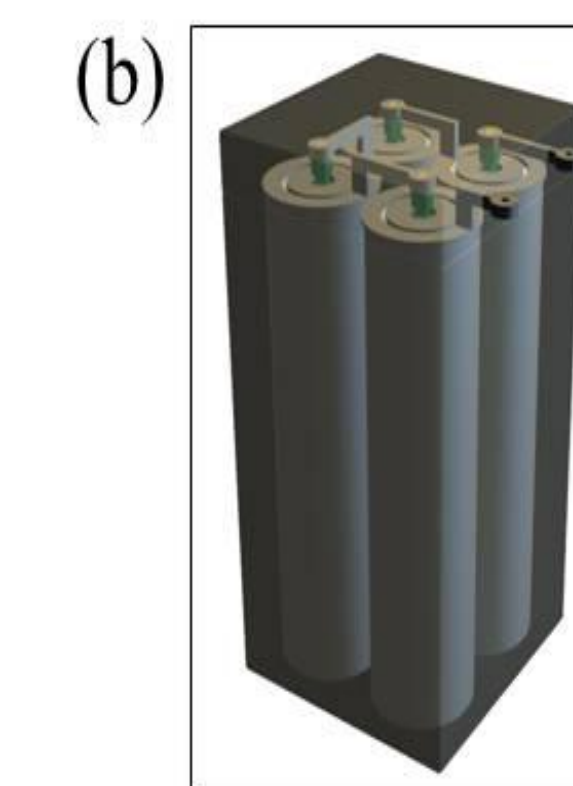
### Issues/Challenges

- Needs improvement in safety
- Needs cost reduction from \$300-500/kWh
- Needs high-power capability

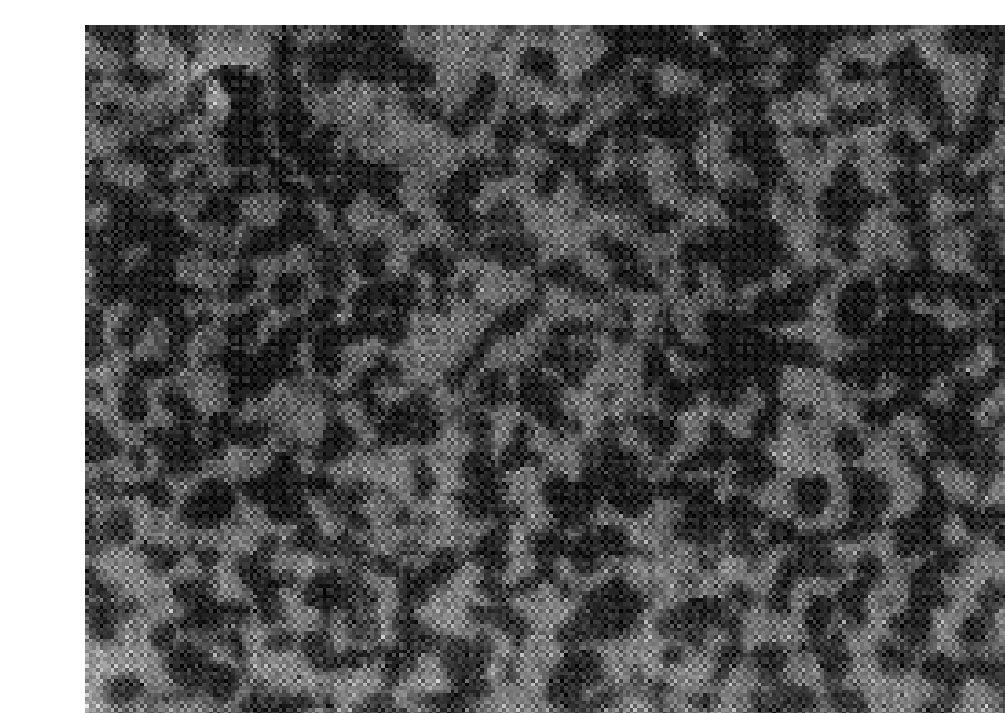
## MSRI's Experience of Na Batteries



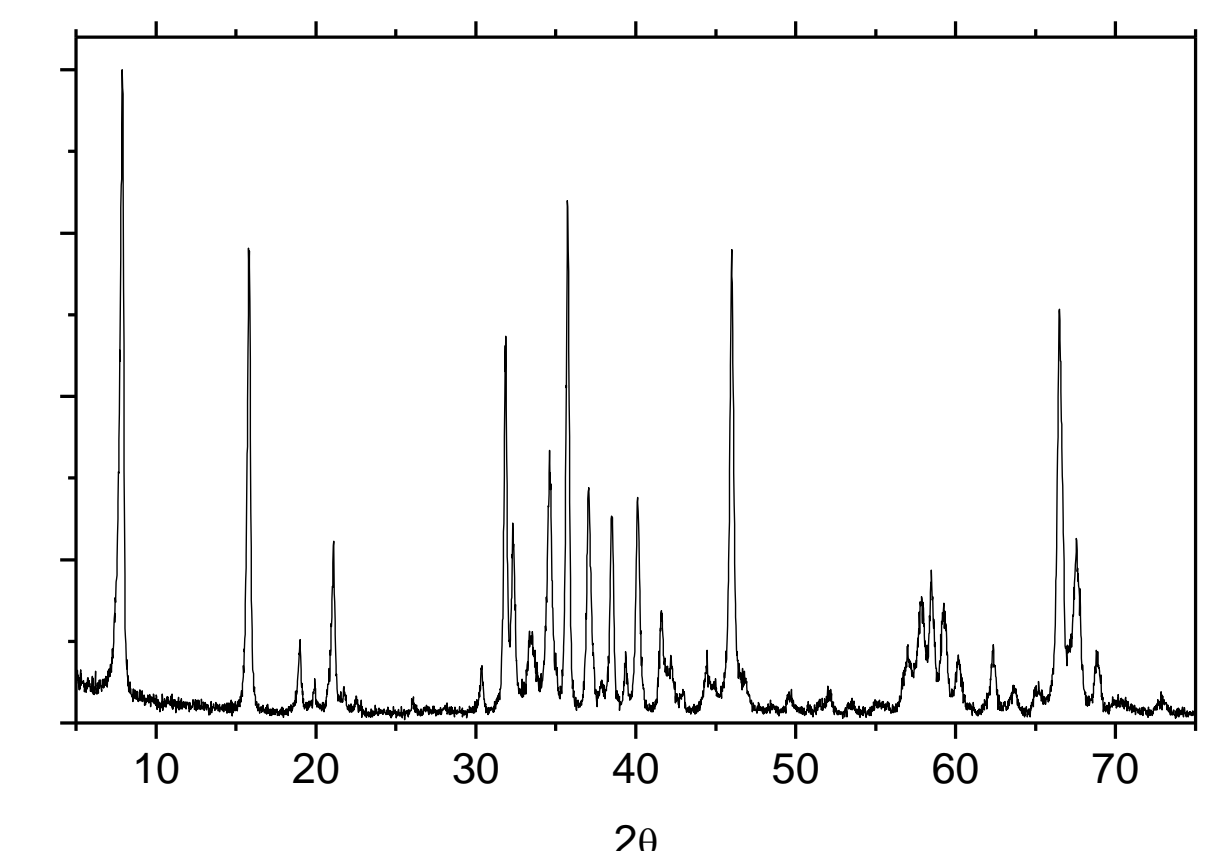
Tubular Cells & Battery Pack



Planar Cells Assembly



Mechanically Strong and Moisture-resistant Composite  $\beta''$ -alumina (Proprietary Technology, U.S. Patent 6,632,763)



Expertise in Powder Processing to Synthesize Low Resistance  $\beta''$ -Alumina Solid Electrolyte (BASE)