



# Welcome To Colorado!

Ruthie C. Swartzlander

October 25, 2005



**COORSTEK**  
*Amazing Solutions.®*

**Colorado**

**Fuel Cell Industry**

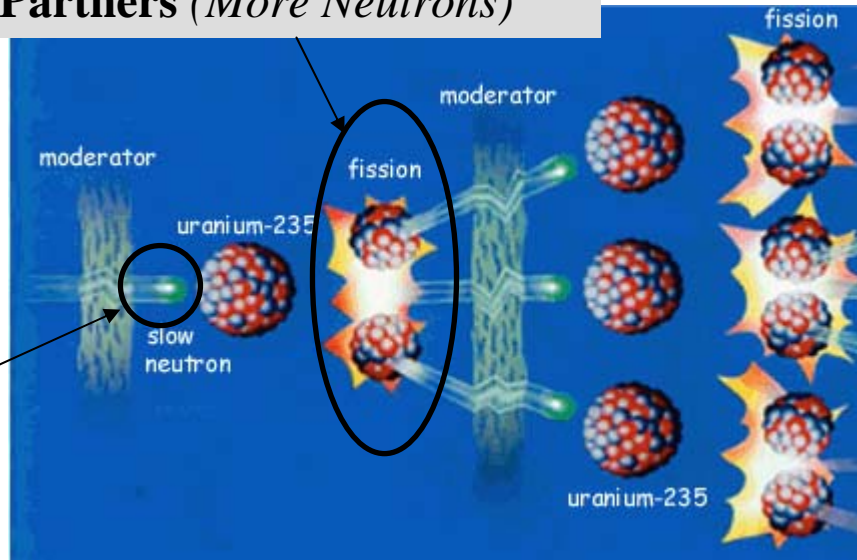
=

**Silicon Valley**

**Semiconductor Industry**

– What does it take to reach critical mass?

**CFCC (Nucleus) + Industry  
Partners (More Neutrons)**



**SECA**  
(*External  
Neutron*)

**At Critical Mass:**  
  
**Chain reaction  
becomes self-sustaining  
(no external neutron  
source needed)**

<http://www.npp.hu/mukodes/lancreakcio-e.htm>

**Scientists**



**Engineers**



**Industry**



**Fuel Cell  
Systems to  
Market**

## **Solving Common Challenges Together**

- Resolve fundamental scientific questions
- Develop phenomenological understanding

- Convert fundamental scientific theory to viable product
- Build and test prototypes, refine

- Scale prototypes and fabrication methods
- Integrate individual components

- Identify customers/market segments
  - Deliver bundle of want satisfying attributes to customers





**Ball Aerospace  
& Technologies Corp.**

**Colorado**  
University of Colorado at Boulder



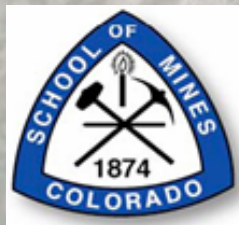
**RENTECH, INC.**

**fuelcellstore.com**™



**UOM TECHNOLOGIES**

**webcom**

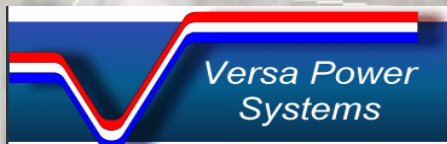


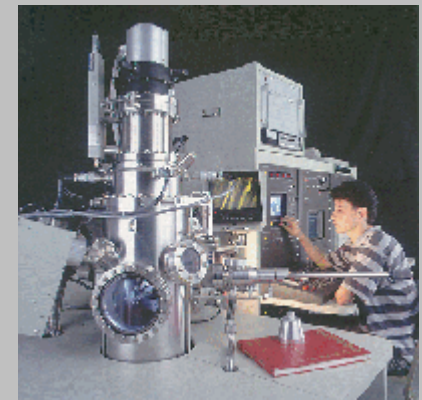
**COORSTEK**  
Amazing Solutions.

**TDA  
Research**

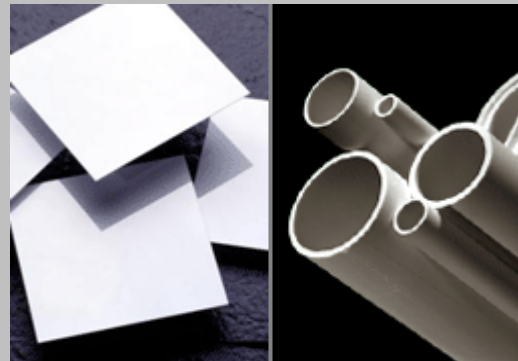


**NREL National Renewable Energy Laboratory**

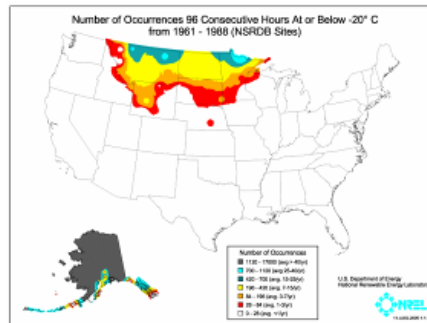
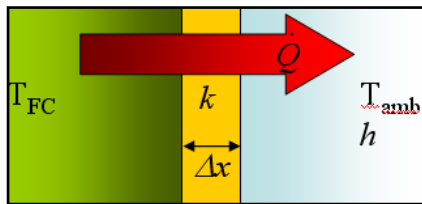








## FCV Systems Analysis: Freeze Solutions



# Buses

**On-Road Fuel Economy Table <sup>(1)</sup>**  
 Data since the inception of the program, all vehicles

**Report Date** *report date of report*  
 Automaker *name of automaker*  
 Vehicle Model *vehicle model*  
 Location of Operation *location of operation*  
 FC Transposed Model *FC Transposed Model*

**Vehicles** *Vehicle* **Comments**

Date	Filing Number	Automaker #	FC (mpg)	kg CO <sub>2</sub> /kg	mixing H <sub>2</sub>	Comments
2/20/2006	1	2006	1	1		
2/20/2006	2	2006	1	1		
2/20/2006	3	2006	1	1		
2/20/2006	4	2006	1	1		
2/20/2006	5	2006	1	1		
2/20/2006	6	2006	1	1		
2/20/2006	7	2006	1	1		
2/20/2006	8	2006	1	1		
2/20/2006	9	2006	1	1		
2/20/2006	10	2006	1	1		
2/20/2006	11	2006	1	1		
2/20/2006	12	2006	1	1		
2/20/2006	13	2006	1	1		
2/20/2006	14	2006	1	1		
2/20/2006	15	2006	1	1		
2/20/2006	16	2006	1	1		
2/20/2006	17	2006	1	1		
2/20/2006	18	2006	1	1		
2/20/2006	19	2006	1	1		
2/20/2006	20	2006	1	1		
2/20/2006	21	2006	1	1		
2/20/2006	22	2006	1	1		
2/20/2006	23	2006	1	1		
2/20/2006	24	2006	1	1		
2/20/2006	25	2006	1	1		
2/20/2006	26	2006	1	1		
2/20/2006	27	2006	1	1		
2/20/2006	28	2006	1	1		
2/20/2006	29	2006	1	1		
2/20/2006	30	2006	1	1		
2/20/2006	31	2006	1	1		
2/20/2006	32	2006	1	1		
2/20/2006	33	2006	1	1		
2/20/2006	34	2006	1	1		
2/20/2006	35	2006	1	1		
2/20/2006	36	2006	1	1		
2/20/2006	37	2006	1	1		
2/20/2006	38	2006	1	1		
2/20/2006	39	2006	1	1		
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2/20/2006	45	2006	1	1		
2/20/2006	46	2006	1	1		
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2/20/2006	56	2006	1	1		
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2/20/2006	59	2006	1	1		
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2/20/2006	62	2006	1	1		
2/20/2006	63	2006	1	1		
2/20/2006	64	2006	1	1		
2/20/2006	65	2006	1	1		
2/20/2006	66	2006	1	1		
2/20/2006	67	2006	1	1		
2/20/2006	68	2006	1	1		
2/20/2006	69	2006	1	1		
2/20/2006	70	2006				

**not real data**

[illegible]

**Top Plot: Voltage (V) vs Current (A)**

Equation:  $V_{pred} = 427.9 - 15.78 \cdot \log(\text{current}) - 0.3370 \cdot \text{current}$

10.0 hours of data per curve fit

12000 data points per curve fit

Time(oper hrs) = 356

**Bottom Plot: Predicted Voltage (V) vs Operating Time (hrs)**

Legend for Bottom Plot:

- @Current = 50A
- @Current = 100A
- @Current = 150A
- @Current = 200A
- @Current = 250A

not real data

Vehicle Data Analysis GUI  
Hydrogen Learning Demonstration Program

1. Data Conversion (Raw Files to Raw Converted)

2. Data Conversion (Raw Converted to Analysis Specific)

*not r*

Fuel Economy	Range	Stack Degradation
<input type="text" value="Ford"/>	<input type="text" value="GM"/>	<input type="text" value="Hyundai"/>

3. Analysis

Fuel Economy	Range	Stack Degradation
<input type="text" value="Vehicle Level"/>	<input type="text" value="Vehicle Level"/>	<input type="text" value="Vehicle Level"/>
<input type="text" value="Fleet Level"/>	<input type="text" value="Fleet Level"/>	<input type="text" value="Fleet Level"/>
<input type="text" value="Trip Length Effect"/>		

4. Analysis Results Figures

Fuel Economy	Range	Stack Degradation
<input type="text" value="DCR"/>	<input type="text" value="DCR"/>	<input type="text" value="DCR"/>



# Fuel Cell Commercialization Opportunities and Challenges

Dr.-Ing. John Coors  
October 25, 2005



Energy



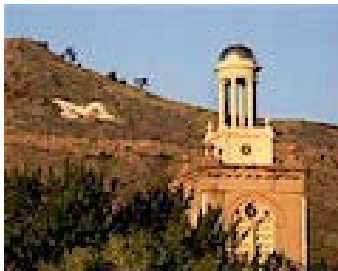
Earth

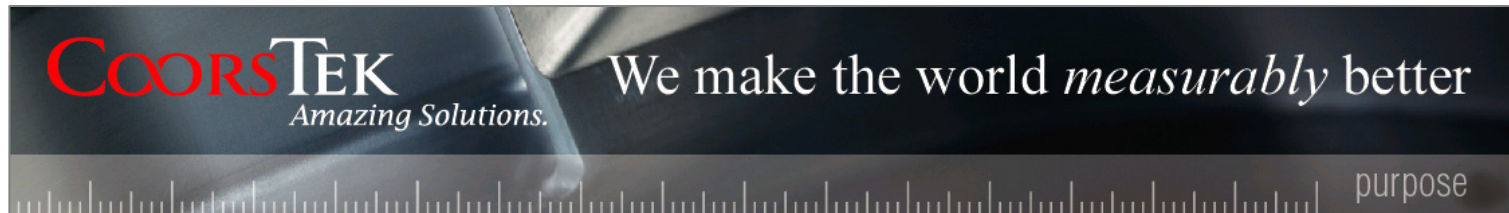


Minerals



Environment





**COORSTEK**  
Amazing Solutions.

## Vision

**CoorsTek Purpose**  
We make the world *measurably* better.

**Core Business Strengths**  
We excel at commercializing technology solutions through our

- Custom engineering
- Materials expertise
- Operational excellence
- *Rapid execution!*

customer solutions

**COORSTEK**  
Amazing Solutions.

## Mission

Our strategy is to provide value in many diverse markets by employing our Core Business Strengths in expanding or developing technology niches.

enabling technology

**COORSTEK**  
Amazing Solutions.

## Values

In everything, we do to others what we would have them do to us.

We do what we say, and say what we mean.

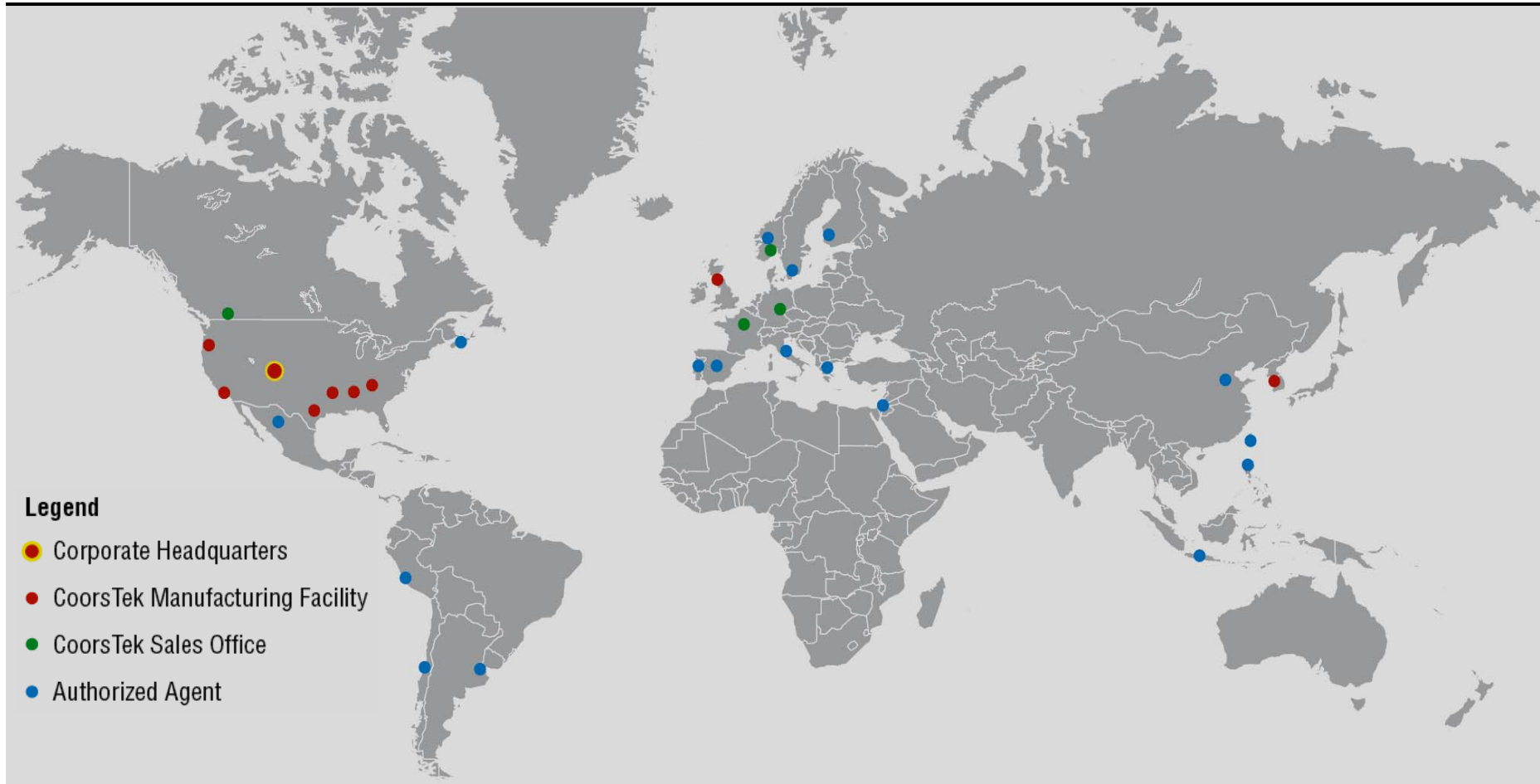
We create outstanding value for our customers.

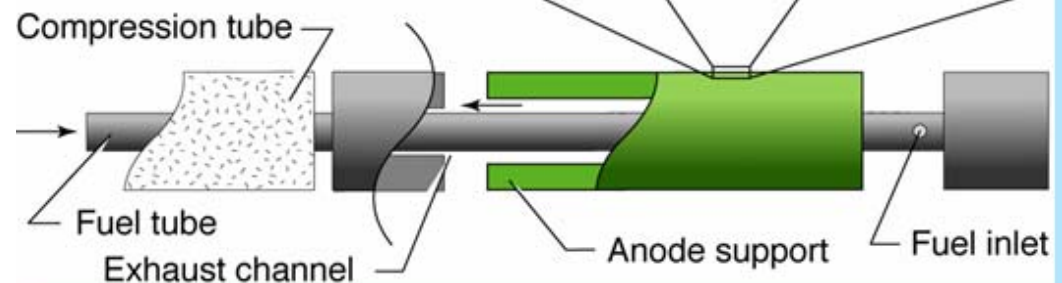
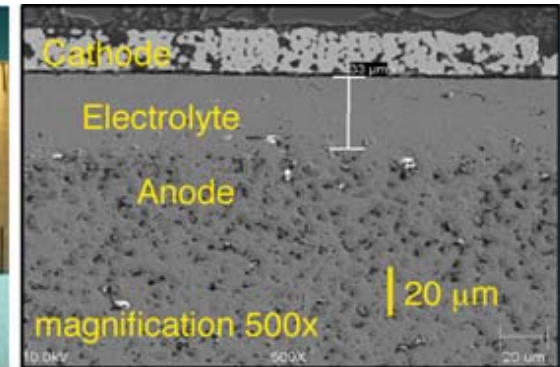
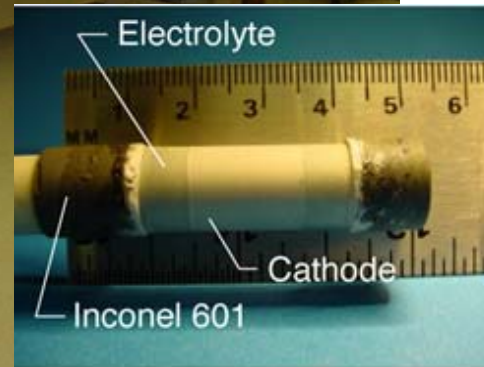
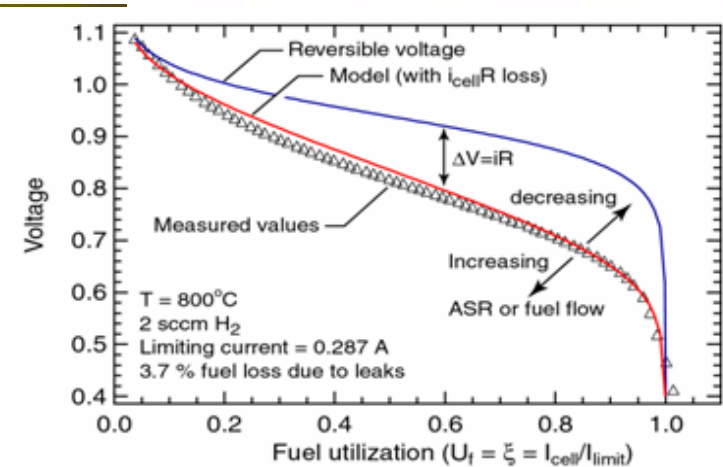
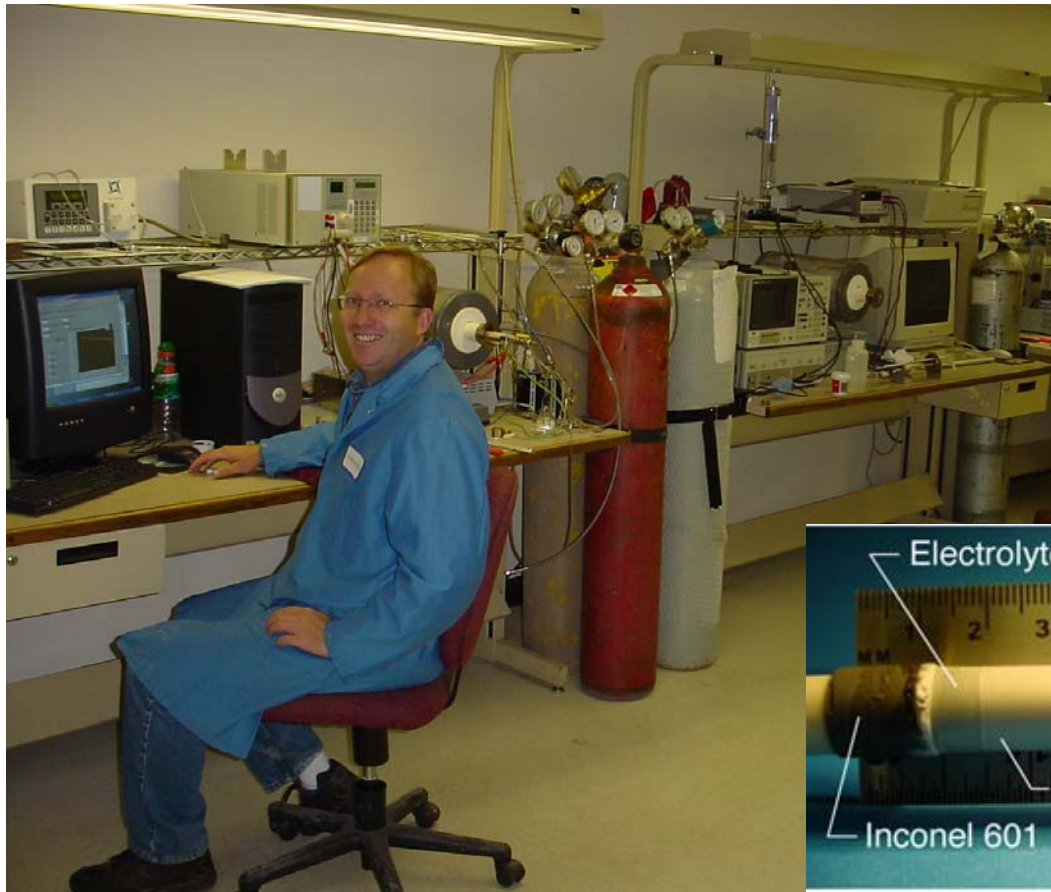
We work together to make our company the best.

foundation



## Worldwide Presence





Our research explores  
the limits of electrical  
efficiency



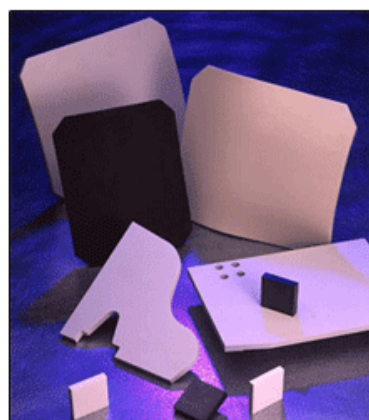
## 70 kW PV System in Burbank, CA



**Avoid  
Technology  
Push**

	PV	SOFC
Power Density	15-25 mW/cm <sup>2</sup>	100 mW/cm <sup>2</sup>
Efficiency	12-18%	60%





specialized components for armor systems

July 15, 2005

## **Soldier survives attack; captures, medically treats sniper (Video)**

During a routine patrol in Baghdad June 2, Army Pfc. Stephen Tschiderer, a medic, was shot in the chest by an enemy sniper, hiding in a van just 75 yards away. The incident was filmed by the insurgents.

Tschiderer, with E Troop, 101st "Saber" Cavalry Division, attached to 3rd Battalion, 156th Infantry Regiment, 256th Brigade Combat Team, 3rd Infantry Division, was knocked to the ground from the impact, but he popped right back up, took cover and located the enemy's position.



Pfc. Stephen Tschiderer is a native of Mendon, N.Y. —

After tracking down the now-wounded sniper with a team from B Company, 4th Battalion, 1st Iraqi Army Brigade, Tschiderer secured the terrorist with a pair of handcuffs and gave medical aid to the terrorist who'd tried to kill him just minutes before.



CoorsTek advanced ceramic plates are used in armored vests

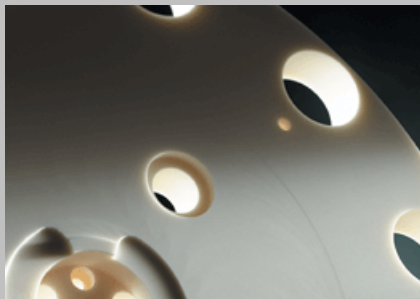
*Movie Clip*



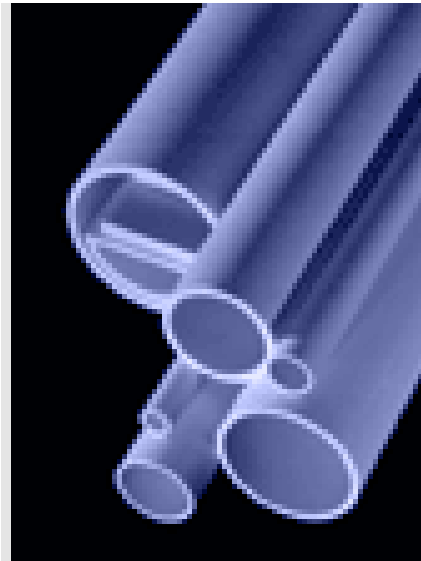


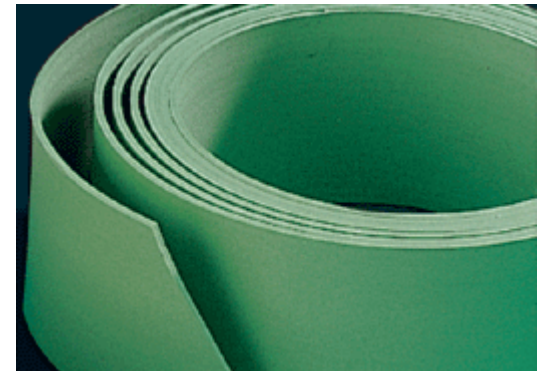
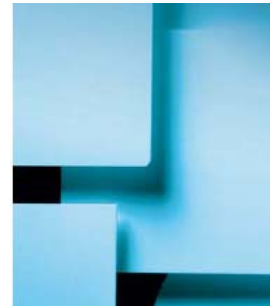
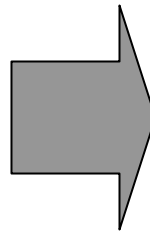
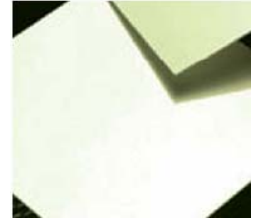
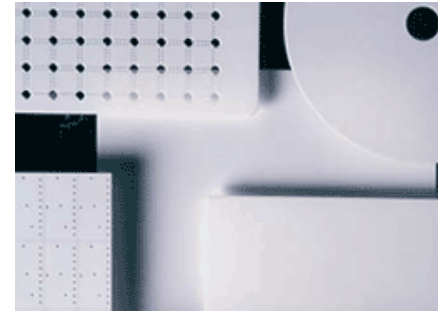
**1,000 metric tonnes of powder  
To make 1 GW of fuel cells**

**=1 month CoorsTek  
current capacity**













**800-Ton Press**  
**15" x 17" Bipolar**  
**Plates**



**High-Fire**



**Machine Plate**



## Earth at Night

NATIONAL GEOGRAPHIC

### LIGHTS OF THE WORLD

While the Earth's night sky glows across its surface in a fairly dense cluster from the vantage of space, the world's night lights are a patchwork of images from clouds that have gathered over a long period. One look across the Atlantic, and you'll see the lights of the United States, Europe, and Japan glow with steady intensity, while Africa, South America, and Australia seem almost dark. But the world's night lights are brighter than they look. In fact, the world's night lights are brighter than they look. In fact, the world's night lights are brighter than they look. In fact, the world's night lights are brighter than they look.



**Playing on the lights**

At night, the world's night lights are a patchwork of images from clouds that have gathered over a long period. One look across the Atlantic, and you'll see the lights of the United States, Europe, and Japan glow with steady intensity, while Africa, South America, and Australia seem almost dark. But the world's night lights are brighter than they look. In fact, the world's night lights are brighter than they look.



**Light fishing**

The blue glow of the night sky is a patchwork of images from clouds that have gathered over a long period. One look across the Atlantic, and you'll see the lights of the United States, Europe, and Japan glow with steady intensity, while Africa, South America, and Australia seem almost dark. But the world's night lights are brighter than they look. In fact, the world's night lights are brighter than they look.

Source: National Geographic Society, NASA, and the University of Michigan



