CRYSTALLINE ENERGY RESEARCH

Energy Storage Research Discovery

New Ceramic Dielectric Crystals Could Potentially Store More Energy Than Batteries

CER is exploring and researching new ways to store electric energy in ceramic dielectric crystals, which could offer transformative energy storage performance beyond the limited performance of electrochemical Lithium-based batteries.

A major discovery has been made that could advance energy storage technology.

The discovery is a new energy storage concept. It does not use any battery electrochemical reactions. The new concept is an unexplored, alternative pathway that could achieve energy densities far above and beyond Lithium-Ion batteries.

Novel ceramic dielectric crystals have been prototyped with calculated dielectric constants (Ks) of 480 million and higher.

The energy storage of a ceramic capacitor is directly proportional to capacitance and voltage, $W= (C/2) (V^2)$. Now the new ceramic dielectric crystals would theoretically have the energy storage potential to surpass the energy densities of Lithium-Ion batteries.

This approach to use novel ceramic dielectric crystals to store energy eliminates the possibility of fires. The energy storage of CER’s crystals would not be limited by the electrochemical ion transport reactions of Lithium-Ion batteries.

Our continuing R&D goals are to optimize the crystal structures and processing variables to enable high voltage charging for energy storage in polarized electron clouds within the crystal structure.

As our R&D program advances, an additional major goal is the development of crystal energy systems adaptable to Electric Vehicles (EVs) like the Nissan LEAF and Testa Models 3 and S. Increased EV driving ranges and other power benefits would result from our higher system energy densities. A possible energy density of 1,280 Wh/Kg could be attained in seconds or minutes, from household 240 VAC or Tesla 480 VDC superchargers.

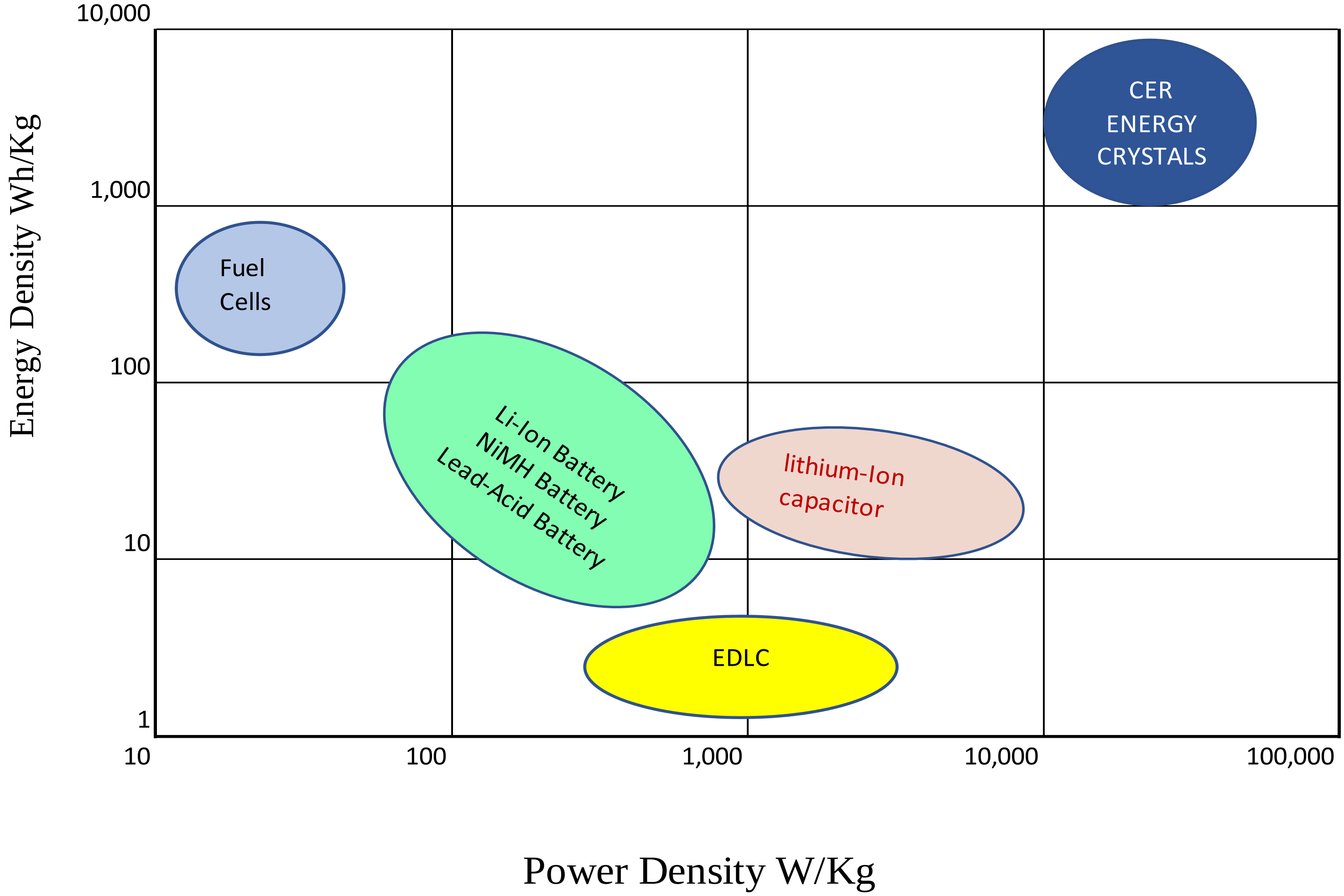
The prototype ceramic dielectric crystals were processed into one layer capacitor disks for testing.

The prototypes exhibit the high K values from -70°C to +250°C, without fires or decomposition.

This discovery opens new research frontiers with unlimited applications in energy storage, capacitors, and electronic components. CER is pursuing IP protection.

CER's theoretical energy storage properties versus Lithium-Ion batteries and other energy storage technologies are illustrated in the following with a prototype photo.

Ragone Plot

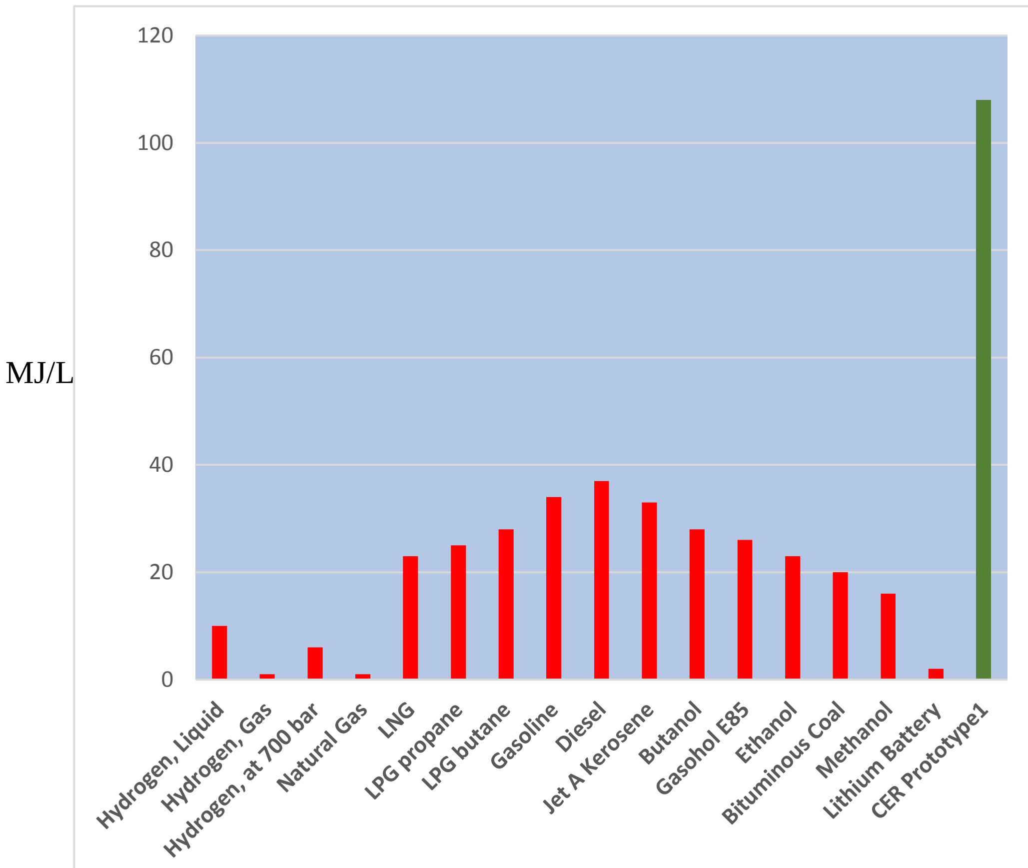

Energy Density Wh/Kg
10,000
1,000
100
10
1
10
100
1,000
10,000
100,000
CER ENERGY CRYSTALS
Fuel Cells
Li-Ion Battery
NiMH Battery
Lead-Acid Battery
lithium-Ion capacitor
EDLC
Power Density W/Kg

CER's Discovery Theoretical Energy Properties
vs.
Lithium-Ion Battery Properties

Properties	CER's Discovery	Li-Ion Batteries
Energy Storage Technology	Ceramic Layered Crystals	Electrochemistry
Chemical Reactions	No	Yes
Fire Possibilities	No	Yes
Electrolyte Usage	No[1]	Yes
Dielectric Constant	480 Million+[2]	N/A
Operating Temperature Range	-70°C to +250°C[2]	-30°C to +70° C
Energy Density (Wh/Kg)	800 to 1,280+[4]	250 to 350
Power Density (W/Kg)	25,000+[4]	1,000 to 3,000
Charge Time	30 to 180 seconds[3]	10 to 60 minutes
Cycle Life	5 Million+[3]	500
Charging Voltage (VDC)	50 to 20 K[3]	2.4 to 4.2
Service Life (Years)	80+[3]	5 to 10
Cost KwH/Kg	\$25 to \$75[3]	\$200

Notes: [1] By design
[2] Prototype results
[3] Predicted
[4] Theoretical

Energy Density Transport Fuels[2]
VS.
CER Prototype Energy Storage Crystals



NOTES:
1. CER Prototype Energy Storage Crystals Theoretical Specific Energy

2. Transport Fuel Chart from: https://investorintel.com/sectors/technology-metals/technology-metals-intel/battery-101-why-lithium/

	Energy Storage Comparison Nissan LEAF Pouch Cell and Panasonic 18650 Battery (2018) Versus Theoretical CER Dielectric Crystals		
	Nissan LEAF Pouch Cell[1]	Panasonic 18650 Battery[2, 3]	CER Dielectric Crystals[5]
			
Capacity: mAh	32,500	3,200	11,300[4]
Approximate cell size	261mm x 216mm x 7.91 mm	65mm x 18.6mm	18.6mm x 18.6mm
Weight	941 grams	48.5 grams	25 grams
Energy Density	224 Wh/Kg	243 Wh/Kg	1,280 Wh/kg

Notes:

[1] https://pushevs.com/2018/01/29/2018-nissan-leaf-battery-real-specs/

[2] https://www.batteryspace.com/prod-specs/NCR18650B.pdf

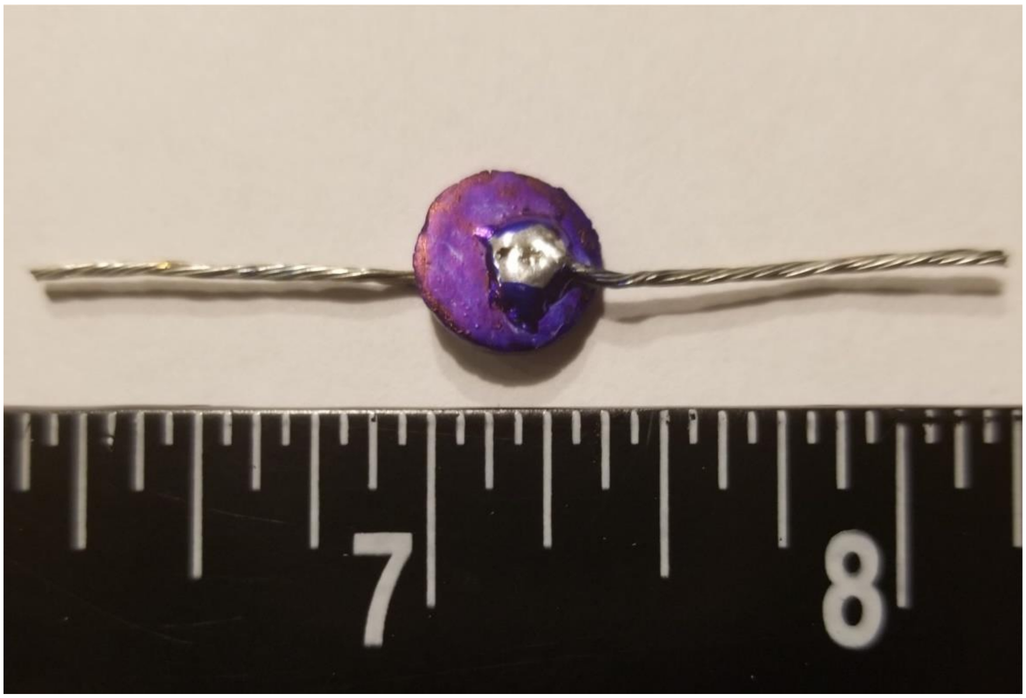
[3] Used in Tesla Models 3 and S

[4] Calculated theoretically from prototypes

[5] Multi-layer construction

CER Prototype

Single layer disc capacitor



140 microfarads

D = 0 .375”

T = 0.087”

Dielectric Constant (K) ≅ 4.92×10^8