

# Carbon-cement supercapacitors as a scalable bulk energy storage solution





## Overview

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Carbon-cement supercapacitors are a scalable bulk energy storage solution<sup>1,2,3</sup>. Researchers at the Massachusetts Institute of Technology (MIT) have discovered that cement and water, combined with a small amount of carbon black, create a powerful, low-cost supercapacitor that could provide a scalable, bulk energy storage solution suitable for a variety of applications<sup>2</sup>. The availability, versatility, and scalability of these carbon-cement supercapacitors opens a horizon for the design of multifunctional structures that leverage high energy storage capacity, high-rate charge/discharge capabilities, and structural strength for sustainable residential and industrial applications<sup>1</sup>. Can material precursors be used for energy storage in supercapacitors?

Herein, we investigate such a scalable material solution for energy storage in supercapacitors constructed from readily available material precursors that can be locally sourced from virtually anywhere on the planet, namely cement, water, and carbon black.

Can concrete-like supercapacitors be used for bulk energy storage?

These properties point to the opportunity for employing these structural concrete-like supercapacitors for bulk energy storage in both residential and industrial applications ranging from energy autarkic shelters and self-charging roads for electric vehicles, to intermittent energy storage for wind turbines.

Can a carbon-cement supercapacitor store energy?

MIT engineers created a carbon-cement supercapacitor that can store large amounts of energy. Made of just cement, water, and carbon black, the device could form the basis for inexpensive systems that store intermittently renewable energy, such as solar or wind energy.

Could a supercapacitor provide cheap and scalable energy storage?

Made of cement, carbon black, and water, the device could provide cheap and scalable energy storage for renewable energy sources. MIT engineers have



created a “supercapacitor” made of ancient, abundant materials, that can store large amounts of energy.

What can carbon-cement supercapacitors do?

Another potential application for carbon-cement supercapacitors is for building concrete roadways that could store energy produced by solar panels alongside the road and then deliver that energy to electric vehicles traveling along the road using the same kind of technology used for wirelessly rechargeable phones.

Are carbon black supercapacitors a good choice for bulk energy storage?

More specifically, high-rate capability supercapacitors rely on through a saturating electrolyte to or away from the surface layer. Herein, we argue that carbon black. This synergy makes our materials good candidates for bulk energy storage for residential and industrial applications.



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Fig. 2. Capacitance measurements and analysis: (A) (1) An electric double layer capacitor (EDLC) composed of (2) two polished, electrolyte saturated carbon-cement electrodes (thickness  $d$ ) separated by (3) a glassy fiber membrane soaked in the same electrolyte (1M KCl), and covered by (4) conductive graphite paper. The electrodes are (5) prestressed in (6) a closed cell to ...

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Fig. 3. Experimentally derived scaling relations: (A) Rate-independent capacitance of eight different carbon-cement electrode materials showing the intensive nature of the energy storage capacity of our electrode systems. (B) Rate-dependent capacitance scaled along the horizontal axis by means of the classical dimensionless diffusion variable  $= d^2/(D t_0)$ . All measured ...



### Engineers create an energy-storing supercapacitor from ancient ...

More information: Chanut, Nicolas, Carbon-cement supercapacitors as a scalable bulk energy storage solution, Proceedings of the National Academy of Sciences (2023). DOI: 10.1073/pnas.2304318120 Journal information: Proceedings of the National Academy of ...



### Carbon-cement supercapacitors as a scalable bulk energy ...



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### New Breakthrough in Energy Storage - MIT Engineers Create

Reference: "Carbon-cement supercapacitors as a scalable bulk energy storage solution" by Nicolas Chanut, Damian Stefaniuk, James C. Weaver, Yunguang Zhu, Yang Shao-Horn, Admir Masic and Franz-Josef Ulm, 31 July 2023, Proceedings of the National.

### Two of humanity's most ancient materials unlock bulk energy storage

Using cement and carbon black, this new tech offers an affordable and scalable energy storage solution for 'fluctuating' renewable energy sources.



### Cement-based structural supercapacitors design and ...

A study by the Massachusetts Institute of Technology in 2023 demonstrated that Carbon cement supercapacitors, This discovery opens up new possibilities for scalable large-scale energy storage solutions in the future. As research in CSSC continues to



### Carbon-cement supercapacitors as a scalable bulk energy ...

The large-scale implementation of renewable energy systems necessitates the development of energy storage solutions to effectively manage imbalances between energy supply and ...



### Paper: "Carbon-cement Supercapacitors as a Scalable Bulk Energy

Herein, we investigate such a scalable material solution for energy storage in supercapacitors constructed from readily available material precursors that can be locally sourced from virtually anywhere on the planet, namely cement, water, and carbon black.



### Engineers create an energy-storing supercapacitor from ancient ...

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### Carbon-cement supercapacitors for bulk energy storage

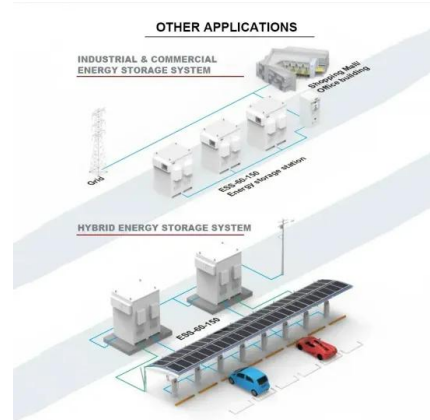
The Massachusetts Institute of Technology (MIT) has developed a scalable bulk energy storage solution with chemical with inexpensive, abundant precursors: cement, water, and carbon black. Their supercapacitors have high storage capacity, high-rate charge-discharge capabilities, and structural strength.





### Carbon-cement supercapacitors as a scalable bulk ...

These properties point to the opportunity for employing these structural concrete-like supercapacitors for bulk energy storage in both residential and industrial applications ranging from energy autarkic shelters and self ...



### [Supercapacitor Made from Concrete and Carbon](#)

In the research reported in the paper, "Carbon-cement supercapacitors as a scalable bulk energy storage solution," published in the Proceedings of the National Academy of Sciences, the team linked three dime-size cylinders to provide enough electricity to power a 3 V light-emitting diode.

### Carbon-cement supercapacitors as a scalable bulk energy storage solution

Mentioning: 3 - The large-scale implementation of renewable energy systems necessitates the development of energy storage solutions to effectively manage imbalances between energy supply and demand. Herein, we investigate such a scalable material solution for energy storage in supercapacitors constructed from readily available material precursors that can be locally ...



### Carbon-cement supercapacitors as a scalable bulk energy storage solution

Fig. 1. Correlative EDS-Raman Spectroscopy analysis: (A) Raman carbon intensity ratios ID/IG obtained from a 200×200 um region of a carbon-cement sample [PBX55 (12), W/C=0.42, nCB/C=0.101; SI Appendix]. The inset displays the D and G bands of the carbon black (PBX55) powder associated, respectively, with defects in



the C-C lattice structure, and the graphitized ...

### Carbon-cement supercapacitors as a scalable bulk energy ...

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### Carbon-cement supercapacitors: A disruptive technology for ...

Carbon-cement supercapacitors: A disruptive technology for renewable energy storage Damian Stefaniuk\*, Nicolas Chanut, James C. Weaver, Yang Shao-Horn, Admir Masic, and Franz-Josef Ulm \* Research Scientist, CSHub, MIT (dstefani@mit )

### Carbon-Cement Supercapacitors for Bulk Energy Storage

Image: Allume Energy Researchers at the Massachusetts Institute of Technology (MIT) have discovered that cement and water, combined with with a small amount of carbon black, create a powerful, low-cost supercapacitor that could provide a scalable, bulk energy

- LiFePO<sub>4</sub>, Battery, safety
- Wide temperature: -20~55°C
- Modular design, easy to expand
- The heating function is optional
- Intelligent BMS
- Cycle Life: > 6000
- Warranty: 10 years





### Carbon-cement supercapacitors as a scalable bulk energy storage

Herein, we investigate one such candidate technology, using chemical precursors which are inexpensive, abundant, and widely available, specifically cement, water, and carbon black. The energy storage capacity of these carbon-cement supercapacitors is

### Carbon-cement supercapacitors as a scalable bulk ...

The availability, versatility, and scalability of these carbon-cement supercapacitors opens a horizon for the design of multifunctional structures that leverage high energy storage capacity,



### Energy-storing supercapacitor from cement, water, black carbon

Carbon-cement supercapacitors as a scalable bulk energy storage solution. Proceedings of the National Academy of Sciences, 2023; 120 (32) DOI: 10.1073/pnas.2304318120 Cite This Page :



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**200kWh  
Battery Cluster**

### **Carbon-cement supercapacitors as a scalable bulk energy storage solution**

SignificanceThe extent and pace of the transition from our current fossil fuel-based economy to one based on renewable energy will strongly depend on the availability of bulk

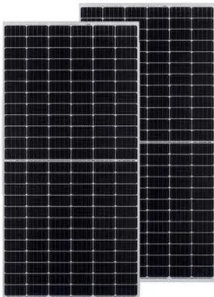
### **Carbon-Cement Supercapacitors Proposed As An Energy Storage Solution**

Although most energy storage solutions on a grid-level focus on batteries, a group of researchers at MIT and Harvard University have proposed using supercapacitors instead, with their 2023 research...



### [MIT engineers create an energy-storing ...](#)

MIT engineers created a carbon-cement supercapacitor that can store large amounts of energy. Made of just cement, water, and carbon black, the device could form the basis for inexpensive systems that store intermittently ...



### **Carbon-cement Supercapacitors as a Scalable Bulk Energy Storage Solution**

MIT engineers have created a "supercapacitor" made of ancient, abundant materials, that can store large amounts of energy. Made of just cement, water, and carbon black (which resembles powdered charcoal), the device could form the basis for inexpensive systems that store intermittently renewable energy, such as solar or wind energy.





### Carbon-cement supercapacitors as a scalable bulk energy ...

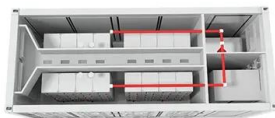
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LFP 48V 100Ah



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### Conductive Concrete - MIT Concrete Sustainability Hub

The CSHub has long investigated multifunctional concrete, and has uncovered a way to store energy in a mixture of carbon black, cement, and water. The technology has potential applications towards bulk energy storage, on-road EV charging, self-heating pavements, energy-autarkic structures, and more.

#### Lithium battery parameters

Product capacity: 100Ah

Product size: 135\*197\*35mm

Product weight: 1.82kg

197mm /7.7in

Product voltage: 3.2V

internal resistance: within 0.5





### [This Supercapacitor Is Made From Cement](#)

To build their supercapacitor, the team mixed together a paste made of cement and water, and then introduced a small amount of carbon black--a fine, charcoal-like form of carbon that has been



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