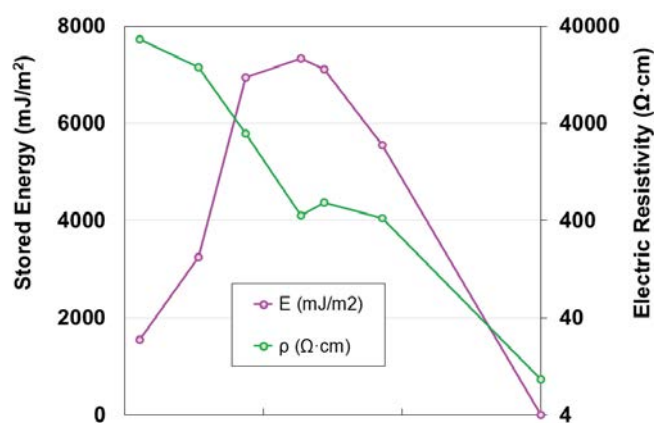


Chitosan Supercapacitors – DOI: <https://doi.org/10.1051/2025505>

Chitin and chitosan (10 Mt/year), the second most abundant organic matter in nature after cellulose (20 Mt/year), are environmentally friendly and renewable biomaterials. Chitosan is primarily obtained from marine crustaceans such as crabs and shrimp, and has been used primarily in medicine.

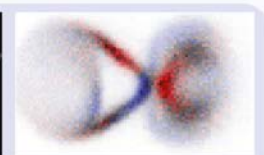
Here, we report that amorphous chitosan nanofibers (AChNFs) containing 13-15% chitin can be transformed into supercapacitors with an energy storage density of 7333.2 mJ/m² by fast charging at 800 V within one second. This is due to the strong positive charge of the amino groups in chitin and chitosan, and the DC electrical resistivity (400- 4,000 Ωcm) required for charging and discharging as an electricity storage material is exactly the same as the electrical conductivity of a solid electrolyte. In contrast to conventional electric-layer capacitors (EDLCs), in which the electrodes are parallel to the circuit, the electrically negative convex portion of the AChNF main chains and the electrically positive concave portion dominated by N-H radicals with permanent dipoles form many electric double layers (EDLs) perpendicular to the electrode. This model shows that the more the EDL density increases (*i.e.*, the more the convex diameter decreases owing to the quantum-size effect), the more the electric storage increases. The conduction electrons were found to be radical electrons on the amine radical N^{*}-H observed in amorphous chitosan. The conduction mechanism due to the nano-uneven diameter and electric double layer, which have a quantum nano-size effect, was illustrated in a schematic diagram. The AChNF supercapacitor is a physical solid-state storage body that is completely different from traditional “wet” batteries, such as EDLCs and lithium-ion batteries, where charging is controlled by the diffusion of ions based on the electrochemical potential. Compared to conventional EDLCs, the AChNF device has advantages, such as a higher charging/discharging voltage, instant charging, larger integration, lighter weight, and prevention of IV drop. While conventional Li-ion liquid batteries are characterized by a low voltage of less than 5V and a long charging time, the AChNF supercapacitor developed in this study is a solid-state energy storage device that can store electricity at a high voltage of up to 800V and instantly charge in less than one second, making it suitable for use as a highly efficient energy storage device for wind power generation, for example. If it can be developed with renewable papers made from natural marine products, it could cast new light on paper electronics such as handheld electronic devices, transportation, and renewable energy storage for power grids. Furthermore, 100% chitosan exhibited the rectifying effect characteristic of semiconductors. ■



▲ Stored energy and DC electric resistivity of the AChNF device as a function of the degree of deacetylation.

MB SCIENTIFIC AB

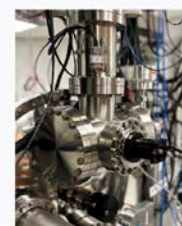
Pushing science forward with state-of-art instrumentation since 2001



The data above was taken by our customer Dr. Tristan Heider and Dr. Lukasz Plucinski using MBS A-L#0016 with Ferrum Spin detector at Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich GmbH. Using MBS A-1 ANALYSER with Ferrum detector.

We challenging every day to develop and produce best possible instruments for the advanced research.

MB Scientific AB is a Swedish company who produces photoelectron spectroscopy instruments & systems. Our state of the art ARPES system MBS AISYS gives you an opportunity for world leading research.



We would love to hear from you!

MBS



TALK TO US

Fälhagsleden 61, 753 23, Uppsala, Sweden
Tel +46 18 29 09 60
email: info@mbscientific.se
home page: mbscientific.se

Reference

- [1] M. Fukuhara, T. Yokotsuka, Y. Omura, T. Yoneda, T. Toda and T. Hashida, Amorphous deacetylated chitosan nanofiber supercapacitors, EPL 151 (2025) 26004.