Manufacturing open-mesoporous carbon nanofibers for flexible and wearable power sources

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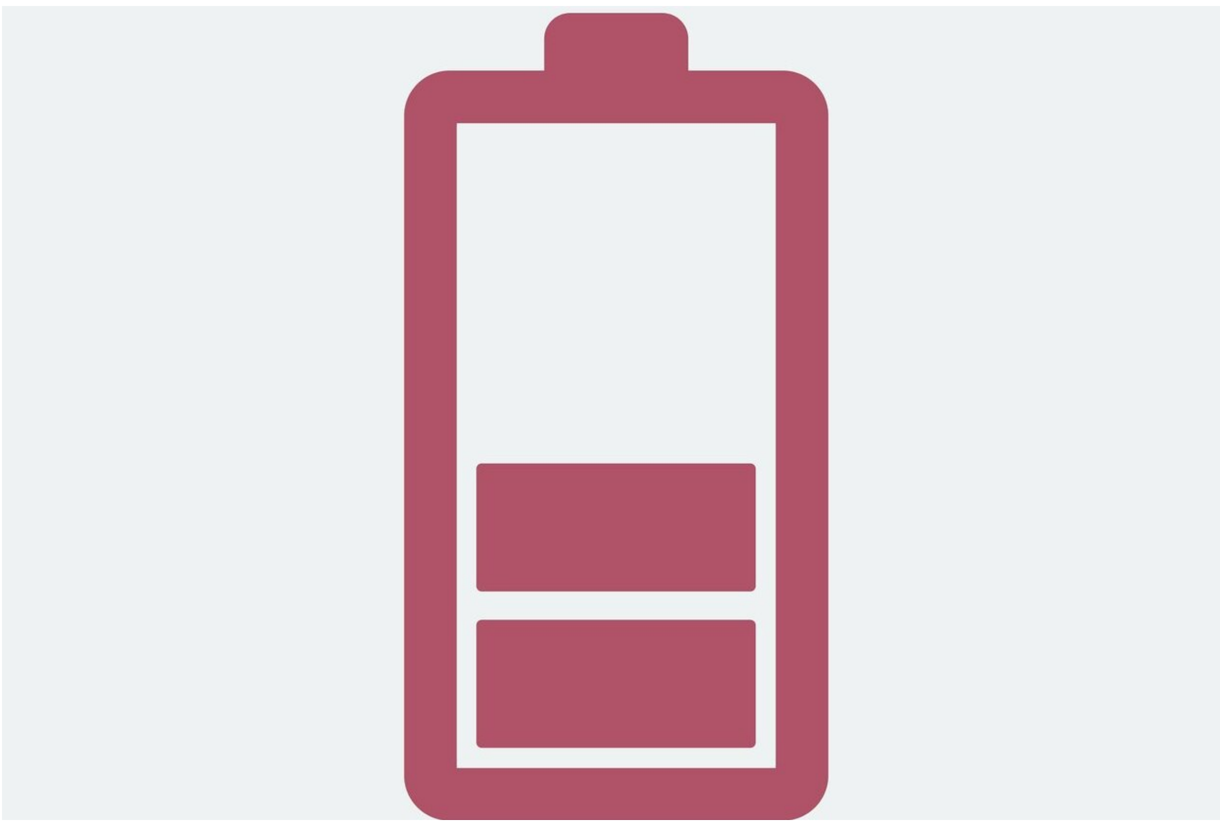

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With the recently increasing development of lightweight, portable, flexible and wearable electronics for health and biomedical devices, there is an urgent need to explore new power sources with higher flexibility and human/tissue-adaptability. Now, researchers have engineered next-generation metal-air batteries, which can be easily fabricated into flexible and wristband-like cells. Though they require further development before they're ready for market, current studies have established solid evidence that these devices could provide enormous opportunities for the next generation of flexible, wearable and bio-adaptable power sources.

"Theoretically, neutral electrolyte based Mg-air batteries possess potential advantages in biomedical applications over other alkaline-based metal-air counterparts," says Dr. Chong Cheng, an AvH research fellow and a carbon nanomaterials specialist at Department of Chemistry in Freie Universität Berlin (Germany). However, the conventional application of Mg-air batteries faced several challenges, one of which is the sluggish kinetics of the oxygen reduction reaction (ORR) in the air cathode. Currently, the rational design of advanced oxygen electrodes for Mg-air batteries with high discharge voltage and capacity under neutral conditions still remains a major challenge. Up to now, researchers have not realized the scalable synthesis of carbon based oxygen electrocatalyst integrated with high ORR catalytic activity, open-mesoporous and interconnected structures, and 3-D porous channels for the air cathode.

To overcome the current limitation on sluggish reaction kinetics of air cathodes in Mg-air batteries, Dr. Chong Cheng at Freie Universität in Berlin and Dr. Shuang Li at Technische Universität Berlin achieved scalable synthesis of atomic Fe-Nx coupled to open-mesoporous N-doped-carbon nanofibers as advanced oxygen electrode for Mg-air batteries.

"Inspired by the fibrous string structures of bufo-spawn, we designed a novel fabrication strategy based on the electrospinning of polyacrylonitrile-branched silica nanoaggregates solution and a secondary coating and carbonization of Fe-doped zeolitic imidazolate frameworks thin layer, which endow the fabricated carbon nanofibers with an open-mesoporous structure and homogeneously coupled atomic Fe-Nx catalytic sites," said the researchers.

The obtained oxygen electrocatalyst and the accordingly constructed air cathode show manifold advantages, which include interconnected structures and 3-D hierarchically porous networks for ions/air diffusion, good bio-adaptability, and high oxygen electrocatalytic performances for both alkaline and neutral electrolytes. Most importantly, the assembled Mg-air batteries with neutral electrolytes reveal high open-circuit voltage, stable discharge voltage plateaus, high capacity, long operating life, and good flexibility.

Mg-air batteries are not yet ready for commercial electronic and biomedical devices, but that future appears a bit closer. "We believe that this novel oxygen electrode can meet the challenges and urgent needs for efficient air cathodes in Mg-air batteries with neutral electrolytes, but more work is still needed," says Prof. Rainer Haag.

More information: Chong Cheng et al. Atomic Fe-Nx Coupled Open-Mesoporous Carbon Nanofibers for Efficient and Bioadaptable Oxygen Electrode in Mg-Air Batteries, *Advanced Materials* (2018). DOI: 10.1002/adma.201802669

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