Scalable graphene technology could significantly enhance battery safety and performance

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Researchers at Swansea University, in collaboration with Wuhan University of Technology, Shenzhen University, have developed a pioneering technique for producing large-scale graphene current collectors. Credit: Swansea University

Researchers at Swansea University, in collaboration with Wuhan University of Technology, Shenzhen University, have developed a pioneering technique for producing large-scale graphene current collectors.

This breakthrough promises to significantly enhance the safety and

performance of lithium-ion batteries (LIBs), addressing a critical challenge in energy storage technology.

Published in *Nature Chemical Engineering*, the study details the first successful protocol for fabricating defect-free graphene foils on a commercial scale. These foils offer extraordinary thermal conductivity—up to 1,400.8 W m^{-1} K^{-1}—nearly ten times higher than traditional copper and aluminum current collectors used in LIBs.

"This is a significant step forward for battery technology," said Dr. Rui Tan, co-lead author from Swansea University. "Our method allows for the production of graphene current collectors at a scale and quality that can be readily integrated into commercial battery manufacturing. This not only improves battery safety by efficiently managing heat but also enhances energy density and longevity."

One of the most pressing concerns in the development of high-energy LIBs, especially those used in electric vehicles, is thermal runaway—a dangerous scenario where excessive heat leads to battery failure, often resulting in fires or explosions. These graphene current collectors are designed to mitigate this risk by efficiently dissipating heat and preventing the exothermic reactions that lead to thermal runaway.

"Our dense, aligned graphene structure provides a robust barrier against the formation of flammable gases and prevents oxygen from permeating the battery cells, which is crucial for avoiding catastrophic failures," explained Dr. Jinlong Yang, co-lead author from Shenzhen University.

The newly developed process is not just a laboratory success but a scalable solution, capable of producing graphene foils in lengths ranging from meters to kilometers. In a significant demonstration of its potential, the researchers produced a 200-meter-long graphene foil with a thickness of 17 micrometers. This foil retained high electrical

conductivity even after being bent over 100,000 times, making it ideal for use in flexible electronics and other advanced applications.

This new approach also allows for the production of graphene foils with customizable thicknesses, which could lead to even more efficient and safer batteries.

This innovation could have wide-reaching implications for the future of energy storage, particularly in electric vehicles and renewable energy systems, where safety and efficiency are paramount.

This international collaborative research team led by Prof Liqiang Mai and Prof Daping He from Wuhan University of technology, Dr. Jinlong Yang from Shenzhen University and Dr. Rui Tan from Swansea University is continuing to refine their process, with ongoing efforts to reduce the thickness of the graphene foils and further enhance their mechanical properties, also exploring this new material beyond Li-ion batteries, such as redox flow batteries and sodium-ion batteries with the assistance from Professor Serena Margodonna's group at Swansea University.

More information: Lun Li et al, Large-scale current collectors for regulating heat transfer and enhancing battery safety, *Nature Chemical Engineering* (2024). DOI: 10.1038/s44286-024-00103-8

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