Rapid cellphone charging getting closer to reality

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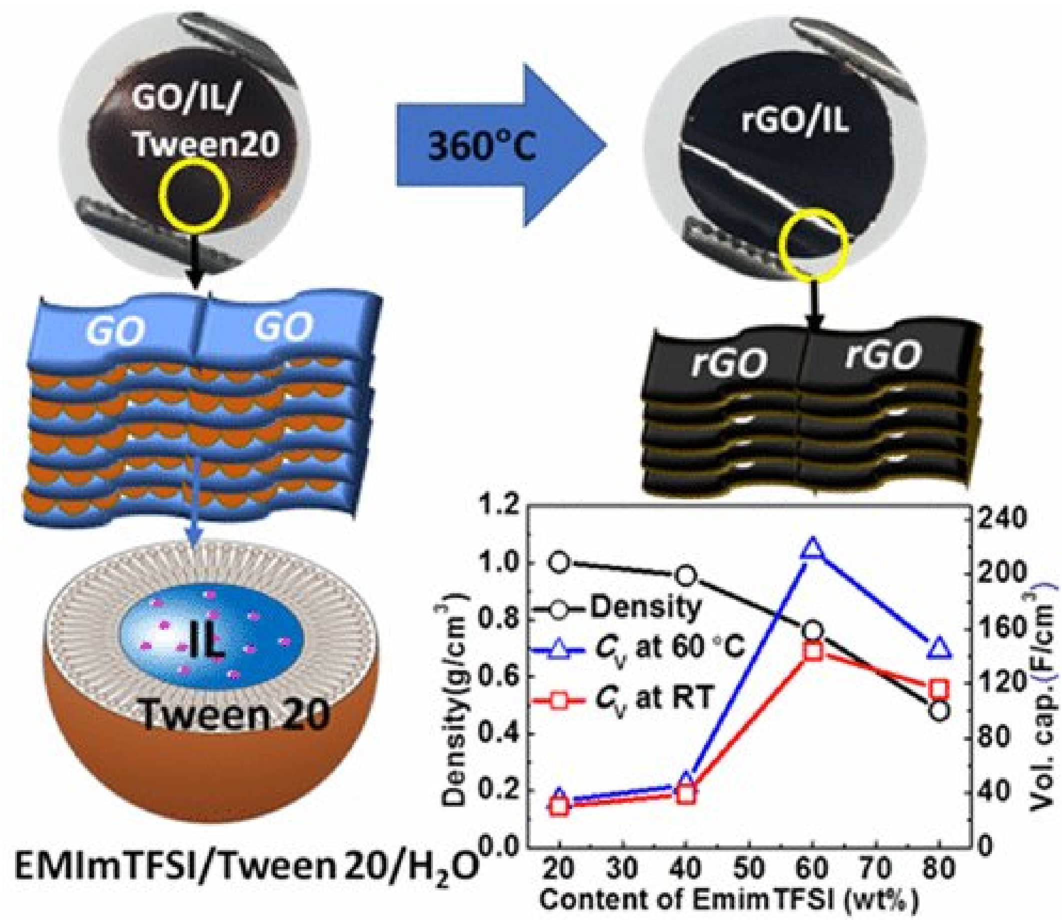

Credit: ACS

The ability to charge cellphones in seconds is one step closer after researchers at the University of Waterloo used nanotechnology to significantly improve energy-storage devices known as supercapacitors.

Their novel design roughly doubles the amount of electrical energy the rapid-charging devices can hold, helping pave the way for eventual use in everything from smartphones and laptop computers, to electric vehicles and high-powered lasers.

"We're showing record numbers for the energy-storage capacity of supercapacitors," said Michael Pope, a professor of chemical engineering who led the Waterloo research. "And the more energy-dense we can make them, the more batteries we can start displacing."

Supercapacitors are a promising, green alternative to traditional batteries—with benefits including improved safety and reliability, in addition to much faster charging—but applications have been limited so far by their relatively low storage capacity.

Existing commercial supercapacitors only store enough energy, for example, to power cellphones and laptops for about 10 per cent as long as rechargeable batteries.

To boost that capacity, Pope and his collaborators developed a method to coat atomically thin layers of a conductor called graphene with an oily liquid salt in supercapacitor electrodes.

The liquid salt serves as a spacer to separate the thin graphene sheets, preventing them from stacking like pieces of paper. That dramatically increases their exposed surface area, a key to maximizing energy-storage capacity.

At the same time, the liquid salt does double duty as the electrolyte needed to actually store electrical charge, minimizing the size and weight of the supercapacitor.

"That is the really cool part of this," Pope said. "It's a clever, elegant design."

The innovation also uses a detergent to reduce the size of the droplets of oily salt - which is combined with water in an emulsion similar to salad dressing - to just a few billionths of a metre, improving their coating action. The detergent also functions like chemical Velcro to make the droplets stick to the graphene.

Increasing the storage capacity of supercapacitors means they can be made small and light enough to replace batteries for more applications, particularly those requiring quick-charge, quick-discharge capabilities.

In the short term, Pope said better supercapacitors could displace lead-acid batteries in traditional vehicles, and be used to capture energy otherwise lost by buses and high-speed trains when they brake.

Further out, although they are unlikely to ever attain the full storage capacity of batteries, supercapacitors have the potential to conveniently and reliably power consumer electronic devices, electric vehicles and systems in remote locations like space.

"If they're marketed in the correct ways for the right applications, we'll start seeing more and more of them in our everyday lives," Pope said.

The research, which also involved Zimin She, PhD student, and Debasis Ghosh, a post-doctoral fellow, was recently published in the journal *ACS Nano*.

More information: Zimin She et al. Decorating Graphene Oxide with Ionic Liquid Nanodroplets: An Approach Leading to Energy-Dense, High-Voltage Supercapacitors, *ACS Nano* (2017). DOI: 10.1021/acsnano.7b04467

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