New research shows candle soot can power the lithium batteries in electric cars

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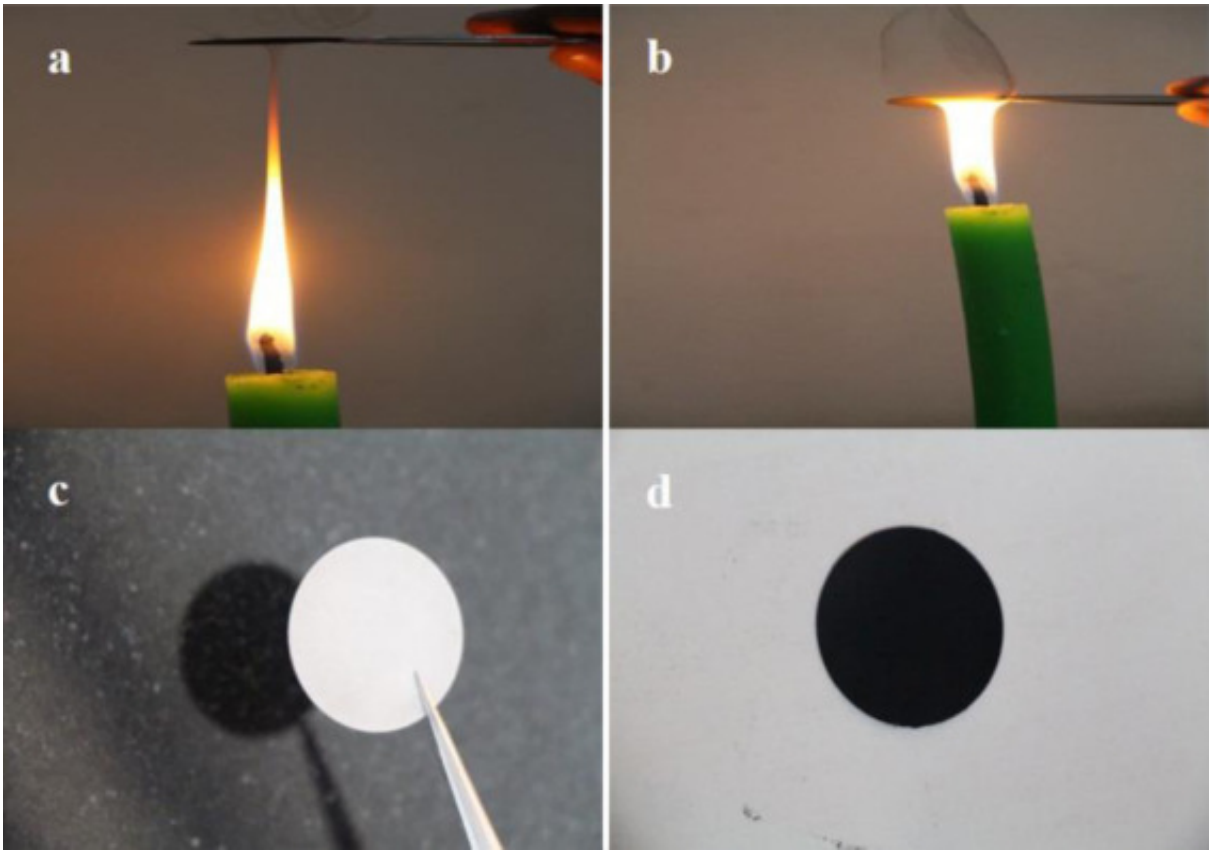

Collecting candle soot from the (a) tip of the flame and (b) middle of the flame. SS current collector (c) before and (d) after deposition of carbon soot. Credit: *Electrochimica Acta*, Volume 180 (October 2015), doi:10.1016/j.electacta.2015.08.124

Burning a candle could be all it takes to make an inexpensive but

powerful electric car battery, according to new research published in Electrochimica Acta. The research reveals that candle soot could be used to power the kind of lithium ion battery used in plug-in hybrid electric cars.

The authors of the study, from the Indian Institute of Technology in Hyderabad, India, say their discovery opens up the possibilities to use carbon in more powerful batteries, driving down the costs of portable power.

Lithium ion batteries power many devices, from smartphones and digital cameras all the way up to cars and even aircraft. The batteries work by having two electrically charged materials suspended in a liquid to produce a current. Carbon is used as one of those materials in smaller batteries, but for bigger, more powerful batteries – such as those used in electric cars – carbon is not suitable because of its structure, which cannot produce the required current density.

In the new study, Dr. Chandra Sharma and Dr. Manohar Kakunuri found that because of the shape and configuration of the tiny carbon nanoparticles, the carbon in candle soot is suitable for use in bigger batteries. What's more, because the soot could be produced quickly and easily, it is a scalable approach to making batteries.

"If you put a water droplet on candle soot it rolls off – that's an observation that's been made in the last few years. The material candle soot is made of, carbon, also has electric potential. So why not use it as an electrode?" asked Dr. Sharma, author of the study from the Indian Institute of Technology. "We looked into it and saw it also shows some exceptional electrochemical properties, so we decided to test it further."

When a candle burns, it gives off clouds of black soot made of carbon. The researchers looked at the soot collected from the tip of a candle

flame and from the middle of the flame and compared the size, shape and structure of the carbon. The results showed that the burning process forms nanoparticles of carbon that are 30-40 nanometers across and are joined together in an interconnected network. They also found that the soot recovered from the tip of a candle flame, which burns at 1400˚C, has fewer impurities like wax, making it perform better as an electrical conductor.

The researchers then analyzed the effectiveness of the soot as a conducting material to use in a battery. The effectiveness of batteries and materials used in batteries can be tested through a technique called cyclic charge-discharge (CCD). The rate of charge/discharge reflects how powerful the battery is; the higher the rate, the more powerful the battery; the results showed that the candle soot carbon performed best at higher rates.

The shape and size of the carbon nanoparticles, and the way they are joined together, means candle soot is a suitable material to use in electric car batteries. Not only is the technology efficient and cost-effective, it is also scalable. Dr. Sharma estimates that one hybrid car would need ten kilograms of carbon soot, which would be deposited in about an hour using candles.

"Generally we overlook the simpler things; candle soot is not new but we're only now looking at it as a potential source of carbon," said Dr. Sharma. "We're very excited about the results. This new approach is very easy and the costs involved are minimal – it would make battery production cheaper."

The researchers now plan to develop a candle soot battery to test the technology further. They are also planning to test hybrid materials that contain candle soot to see if they can make it an even better material for batteries.

More information: "Candle Soot derived Fractal-like Carbon Nanoparticles Network as High-Rate Lithium Ion Battery Anode Material." *Electrochimica Acta*, Volume 180 (October 2015), DOI: 10.1016/j.electacta.2015.08.124

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