Using electrified spatiotemporal heating to depolymerize plastics

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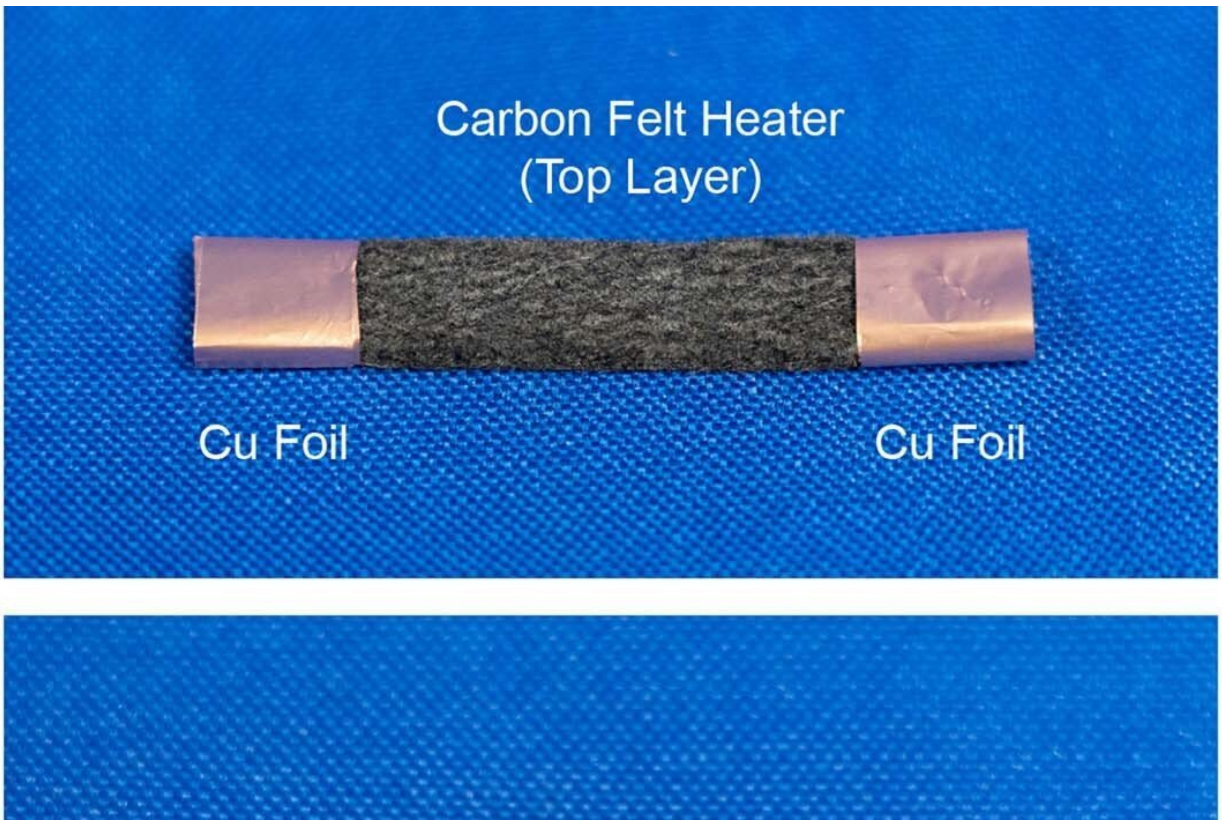

The assembly of the STH system. A thinner layer of carbon felt (about 2.3 mm) is used as the top heater layer. The two ends of the top heater layer are wrapped with Cu foil electrodes for Joule heating. The top and bottom layers are placed in soft contact (without external pressure) for the STH process. A quartz tube with 10.5 mm inner diameter was used to contain the carbon bilayer structure and the reactant reservoir. The bottom image shows the heater layer exhibiting a bright orange color as we apply an electrical current through the top heater layer, demonstrating its Joule-heating capabilities. Credit: *Nature* (2023). DOI:

10.1038/s41586-023-05845-8

A team of engineers and materials scientists affiliated with multiple institutions in the U.S., has developed a new way to depolymerize plastics using electrified spatiotemporal heating. In their paper, published in the journal *Nature*, the group describes the new process and its efficiency. *Nature* has also published a Research Briefing in the same journal issue outlining the work done by the team.

Over the past several years, plastic pollution has become a major concern, both for the environment and for the health of plants and animals, including humans, and scientists are seeking ways to recycle it. Most of the techniques developed thus far involve using chemicals to depolymerize plastics. These efforts are still extremely inefficient, however, with yields between 10% and 25%. In this new effort, the team has found a way to use pulsed electricity to boost the yield to approximately 36%.

The approach involved designing a new kind of reactor with a porous carbon felt bilayer and a pulsed electric heater at the top. In their reactor, plastic bits are melted as they are fed in to the upper chamber and flow as a mass into a lower chamber, where the material is pushed through the felt filter. The plastic then begins to decompose as the temperature rises. As the molecules that make up the plastic become smaller, their volatility grows until they are expelled from the reactor as a gas, which allows more liquid to be drawn in. Using electricity to heat the plastic allows for oscillating the temperature, allowing simpler depolymerization reactions to take precedence over side reactions, which need additional heating to depolymerize.

In addition to improving efficiency, the new approach uses less energy because of the oscillating instead of constant heat source. The team notes the system could be made more eco-friendly by using renewable sources for the electricity. They note that their reactor does emit other materials, such as acetylene, methane and some larger molecules, along with some aromatics. They also acknowledge that more work is required to reduce the amount of carbon released during the reactions.

More information: Qi Dong et al, Depolymerization of plastics by means of electrified spatiotemporal heating, *Nature* (2023). DOI: 10.1038/s41586-023-05845-8

Benjamin Thompson et al, A smarter way to melt down plastics?, *Nature* (2023). DOI: 10.1038/d41586-023-01348-8