

Engineers transform brewery wastewater into energy storage

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Equipment at a brewery. Credit: FTGallo / Wikipedia.

University of Colorado Boulder engineers have developed an innovative bio-manufacturing process that uses a biological organism cultivated in brewery wastewater to create the carbon-based materials needed to make

energy storage cells.

This unique pairing of breweries and batteries could set up a win-win opportunity by reducing expensive wastewater treatment costs for beer makers while providing manufacturers with a more cost-effective means of creating renewable, naturally-derived fuel cell technologies.

"Breweries use about seven barrels of water for every barrel of beer produced," said Tyler Huggins, a graduate student in CU Boulder's Department of Civil, Environmental and Architectural Engineering and lead author of the new study. "And they can't just dump it into the sewer because it requires extra filtration."

The process of converting biological materials, or biomass, such as timber into carbon-based battery electrodes is currently used in some energy industry sectors. But, naturally-occurring biomass is inherently limited by its short supply, impact during extraction and intrinsic chemical makeup, rendering it expensive and difficult to optimize.

However, the CU Boulder researchers utilize the unsurpassed efficiency of biological systems to produce sophisticated structures and unique chemistries by cultivating a fast-growing fungus, *Neurospora crassa*, in the sugar-rich wastewater produced by a similarly fast-growing Colorado industry: breweries.

"The wastewater is ideal for our fungus to flourish in, so we are happy to take it," said Huggins.

By cultivating their feedstock in wastewater, the researchers were able to better dictate the fungus's chemical and physical processes from the start. They thereby created one of the most efficient naturally-derived lithium-ion battery electrodes known to date while cleaning the wastewater in the process.

The findings were published recently in the American Chemical Society journal *Applied Materials & Interfaces*.

If the process were applied on a large scale, breweries could potentially reduce their municipal wastewater costs significantly while manufacturers would gain access to a cost-effective incubating medium for advanced battery technology components.

"The novelty of our process is changing the manufacturing process from top-down to bottom-up," said Zhiyong Jason Ren, an associate professor in CU Boulder's Department of Civil, Environmental and Architectural Engineering and a co-author of the new study. "We're biodesigning the materials right from the start."

Huggins and study co-author Justin Whiteley, also of CU Boulder, have filed a patent on the process and created Emergy, a Boulder-based company aimed at commercializing the technology.

"We see large potential for scaling because there's nothing required in this process that isn't already available," said Huggins.

The researchers have partnered with Avery Brewing in Boulder in order to explore a larger pilot program for the technology. Huggins and Whiteley recently competed in the finals of a U.S. Department of Energy-sponsored startup incubator competition at the Argonne National Laboratory in Chicago, Illinois.

"This research speaks to the spirit of entrepreneurship at CU Boulder," said Ren, who plans to continue experimenting with the mechanisms and properties of the fungus growth within the wastewater. "It's great to see students succeeding and creating what has the potential to be a transformative technology. Energy storage represents a big opportunity for the state of Colorado and beyond."

More information: Tyler M. Huggins et al. Controlled Growth of Nanostructured Biotemplates with Cobalt and Nitrogen Codoping as a Binderless Lithium-Ion Battery Anode, *ACS Applied Materials & Interfaces* (2016). [DOI: 10.1021/acsami.6b09300](https://doi.org/10.1021/acsami.6b09300)

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