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# Biomass-based polymer can capture and release $CO_2$ without high pressure or extreme temperatures

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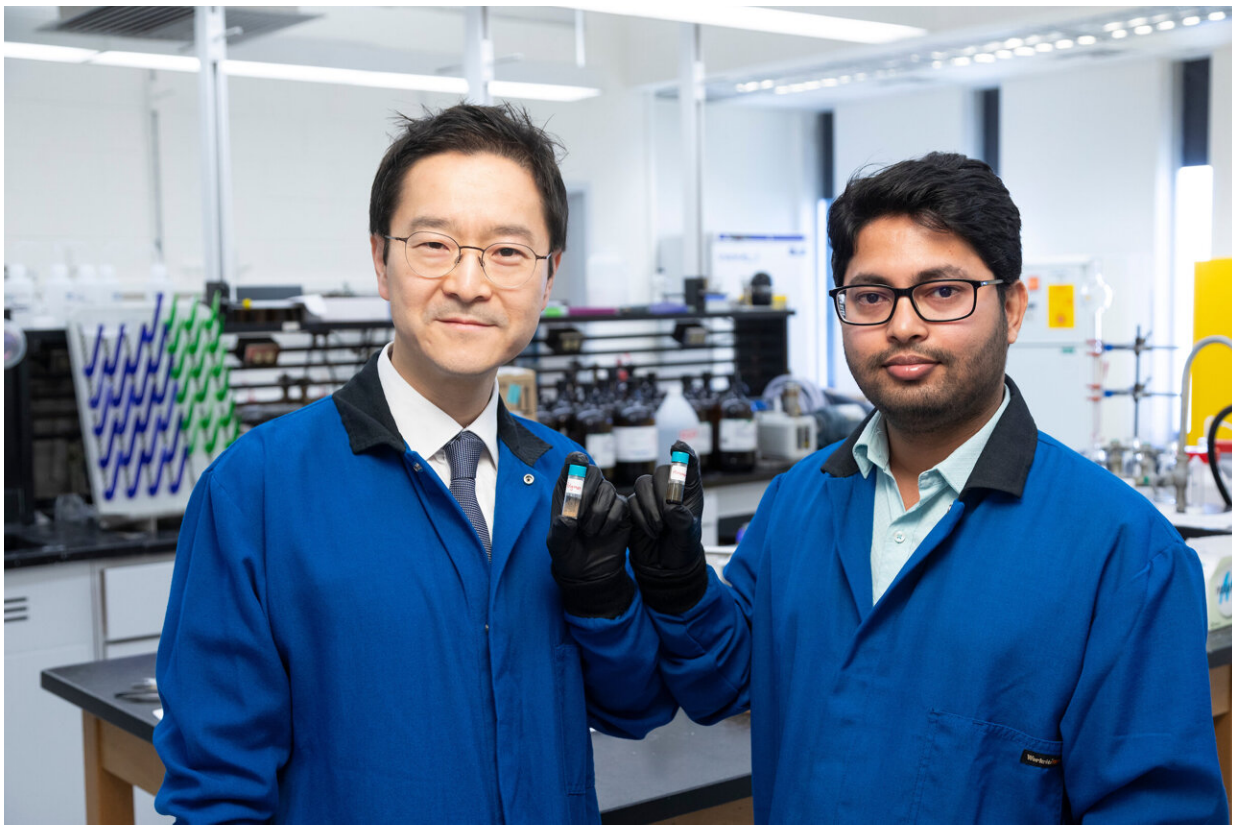

Hoyong Chung, an associate professor in the FAMU-FSU College of Engineering, and postdoctoral researcher Arijit Ghorai developed a new, biomass-based material that can be used to repeatedly capture and release carbon dioxide. Credit: Scott Holstein/FAMU-FSU College of Engineering

A new, biomass-based material developed by FAMU-FSU College of Engineering researchers can be used to repeatedly capture and release carbon dioxide.

The material is primarily made from lignin, an organic molecule that is a main component of wood and other plants, and it can take up carbon dioxide ($CO_2$) from concentrated sources or directly from the air. The research appears in *Advanced Materials*.

"The beauty of this work is the ability to precisely control the capture and release of $CO_2$ without high pressure or extreme temperatures," said study co-author Hoyong Chung, an associate professor in the FAMU-FSU College of Engineering. "Our testing showed that this material's structure stayed the same even after being used multiple times, making this a promising tool for mitigating carbon emissions."

In previous research, Chung's team developed a lignin and $CO_2$-based polymer that represented a potential alternative to traditional petroleum-based plastic. This paper takes that research further, showing the possibility of reversing the process and of reusing the material to absorb $CO_2$ again in the future.

Because it is found in plants, lignin is abundant and cheap, and it is often harvested as a byproduct from wood processing. Scientists are working to find new ways to use this natural resource.

One gram of the material developed by Chung's team captured 47 milligrams—about 5% of the weight of the original material—of $CO_2$ from a concentrated source and 26 milligrams from exposure to ambient air. The absorbed $CO_2$ can be permanently sequestered, or it can be released for use in various applications, such as manufacturing, agriculture and others.

Researchers were surprised by the release mechanism. While using nuclear magnetic resonance spectroscopy to analyze a sample, they saw bubbles appear when the sample was heated.

"That sparked our curiosity," Chung said. "What's going on here? Why do we see these little bubbles every time we try to analyze this polymer?"

Further investigation revealed that heat was causing the material to release $CO_2$. The researchers investigated the reaction and found that by controlling the heat applied to the sample, they were able to control the amount of $CO_2$ released. They also showed the possibility of using that captured gas in other reactions.

It only takes temperatures of about 60 degrees Celsius at normal atmospheric pressure to release the $CO_2$, meaning high temperatures and pressures aren't necessary for the reuse process. This $CO_2$ release temperature can be increased or decreased for different applications.

"This is like a sponge for $CO_2$, absorbing it, releasing it and drying up so it can capture more," Chung said. "It's fascinating to see what is possible with this material."

Postdoctoral researcher Arijit Ghorai was the lead author of the study.

**More information:** Arijit Ghorai et al, Ionic Lignin Polymers for Controlled CO2 Capture, Release, and Conversion into High-Value Chemicals, *Advanced Materials* (2024). DOI: 10.1002/adma.202406610

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