Researchers unravel the workings of a unique carbon capture technology

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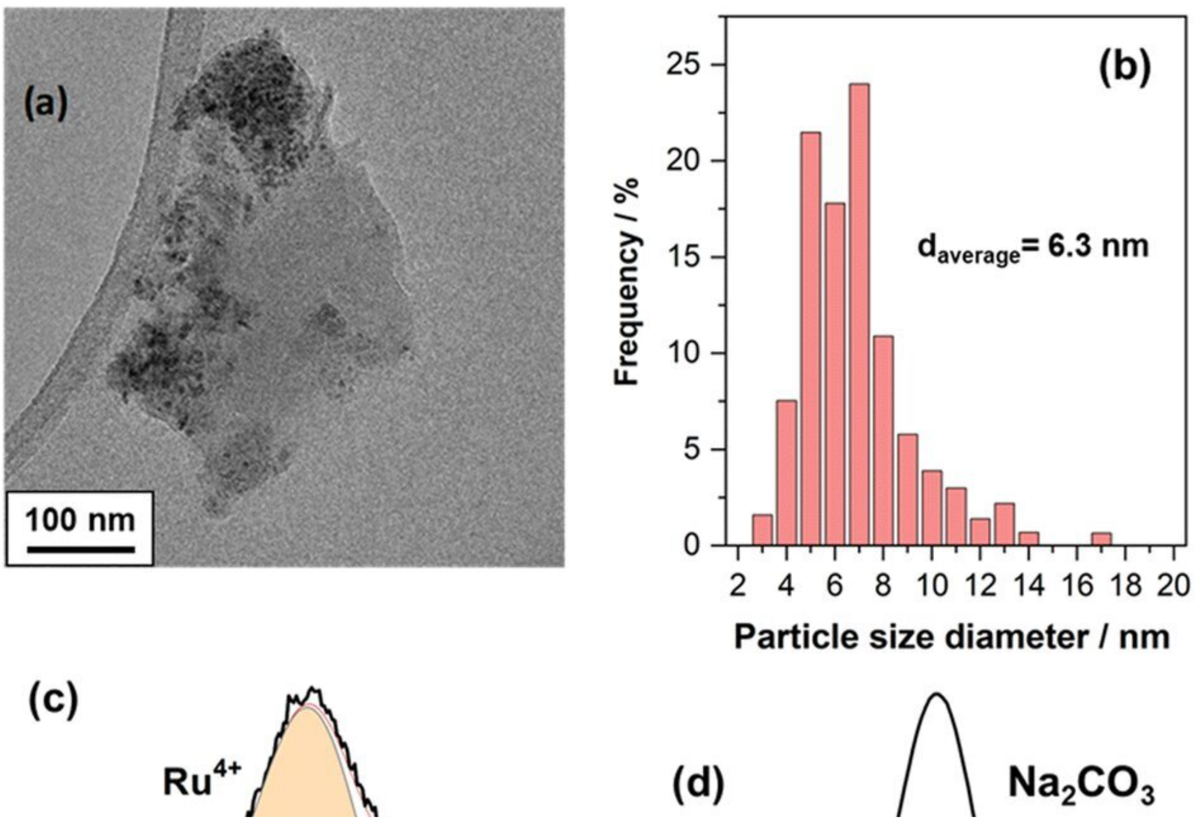

Ex situ characterization of NiRuNa sample (a) representative TEM image. (b) Particle size distribution based on TEM images. (c) Ru 3p XPS region. (d) Na 1s XPS region. Credit: *Journal of Materials Chemistry A* (2023). DOI: 10.1039/D3TA01892J

The U.K. can lead the way in technologies that effectively capture carbon dioxide and convert them into useful products such as hydrogen, says Dr. Melis Duyar, an expert in carbon capture technology from the University of Surrey.

The comments come after Surrey's research team conducted a first-of-its-kind experiment to understand how their new technology, which uses a switchable dual-function material (DFM), captures and converts carbon dioxide (CO_2) into green fuels or useful industrial chemicals. The study is published in the *Journal of Materials Chemistry A*.

The Surrey team's switchable DFM, NiRuNa/CeAl , consists of nanoparticles of a bimetallic alloy, in combination with a dispersed Na-based adsorbent. These elements are combined to create a unique material for capturing and converting CO_2 in not just one, but three chemical reactions, offering versatility in an ever-changing energy landscape.

Dr. Melis Duyar, lead author of the study from the University of Surrey, said, "Pursuing advanced carbon capture technology is more than just the right thing to do for our planet—it's an exceptional opportunity for the U.K. to emerge as a global front-runner, leveraging the vast potential of green energy products born from this process.

"We'll continue to apply the lessons learned from this study and work with others in the higher education sector and industry to continue to mature this process."

Dr Melis Duyar. Credit: University of Surrey

Surrey researchers found that NiRuNa/CeAl can be used to capture CO_2 in three important chemical reactions:

- CO_2 methanation (converting CO_2 into methane)—a process where CO_2 is converted into methane. It combines CO_2 with hydrogen (H_2) to produce methane (also called "synthetic natural gas") and water.
- Reverse water-gas shift—a chemical process that involves the conversion of CO_2 and H_2 into carbon monoxide (CO) and water (H_2O). This reaction can be used to make sustainable "synthesis gas" which is a mixture of CO and H_2, that can be converted to a vast variety of chemicals using techniques that already exist within the chemical industry, moving us closer to a circular economy.

- Dry reforming of methane (DRM)—a chemical process that involves the conversion of methane and CO_2 into "synthesis gas," taking advantage of underutilized hydrocarbon resources such as biogas and offering opportunities for decarbonization and CO_2 recycling in the absence of green hydrogen.

By using a technique called operando-DRIFTS-MS, the team were able to observe interactions of molecules with the surface of these unique dual-function materials while CO_2 was being captured and while it was further converted to products via these three reactions. This allows researchers to determine what makes a DFM work, greatly advancing their ability to design high-performance materials.

Duyar says, "Capturing and using carbon dioxide is key to reaching the ultimate goal of net zero by 2050. We now have a clearer understanding of how switchable DFMs are able to perform a multitude of reactions directly from captured CO_2, which will help us improve the performance of these materials even more via rational design."

More information: Loukia-Pantzechroula Merkouri et al, Unravelling the CO2 capture and conversion mechanism of a NiRu–Na2O switchable dual-function material in various CO2 utilisation reactions, *Journal of Materials Chemistry A* (2023). DOI: 10.1039/D3TA01892J

Provided by University of Surrey

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