

Lunar soil has the potential to generate oxygen and fuel

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This photograph shows a lunar soil sample returned by China's Chang'e 5 spacecraft. Credit: Yingfang Yao

Soil on the moon contains active compounds that can convert carbon dioxide into oxygen and fuels, scientists in China report May 5 in the journal *Joule*. They are now exploring whether lunar resources can be used to facilitate human exploration on the moon or beyond.

Nanjing University material scientists Yingfang Yao and Zhigang Zou hope to design a system that takes advantage of lunar [soil](#) and [solar radiation](#), the two most abundant resources on the moon. After analyzing the lunar soil brought back by China's Chang'e 5 spacecraft, their team found the sample contains compounds—including iron-rich and titanium-rich substances—that could work as a catalyst to make desired products such as oxygen using sunlight and carbon dioxide.

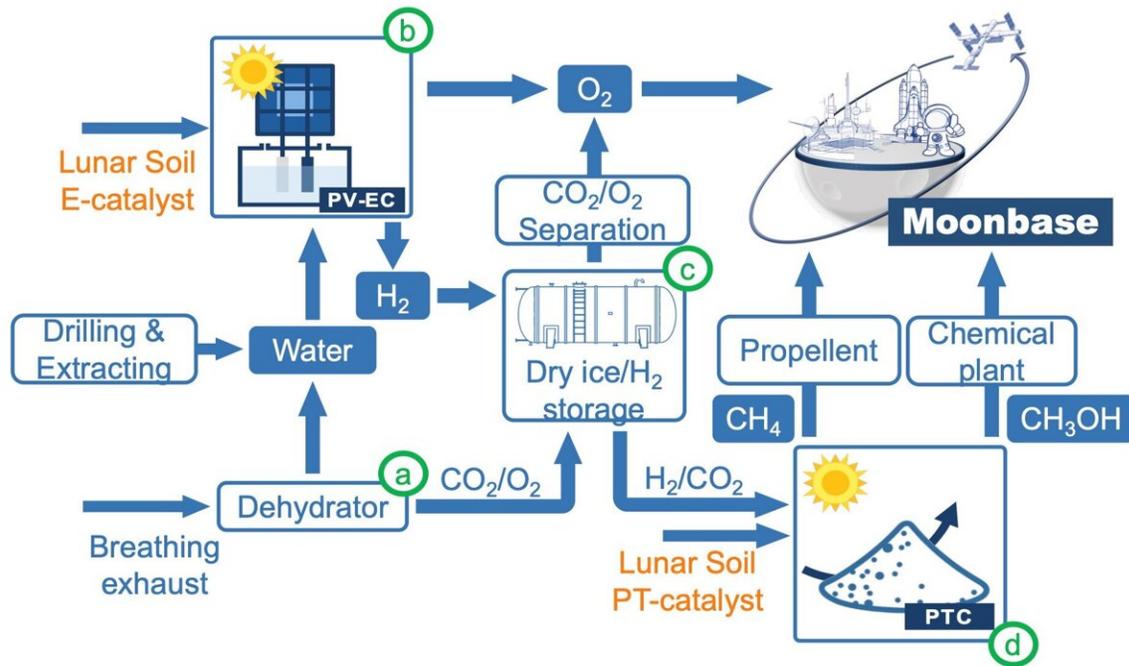
Based on the observation, the team proposed an "extraterrestrial photosynthesis" strategy. Mainly, the system uses lunar soil to electrolyze water extracted from the moon and in astronauts' breathing exhaust into oxygen and hydrogen powered by sunlight. The carbon dioxide exhaled by moon inhabitants is also collected and combined with hydrogen from water electrolysis during a hydrogenation process catalyzed by lunar soil.

The process yields hydrocarbons such as methane, which could be used as fuel. The strategy uses no external energy but sunlight to produce a variety of desirable products such as water, oxygen, and fuel that could support life on a moonbase, the researchers say. The team is looking for an opportunity to test the system in space, likely with China's future crewed lunar missions.

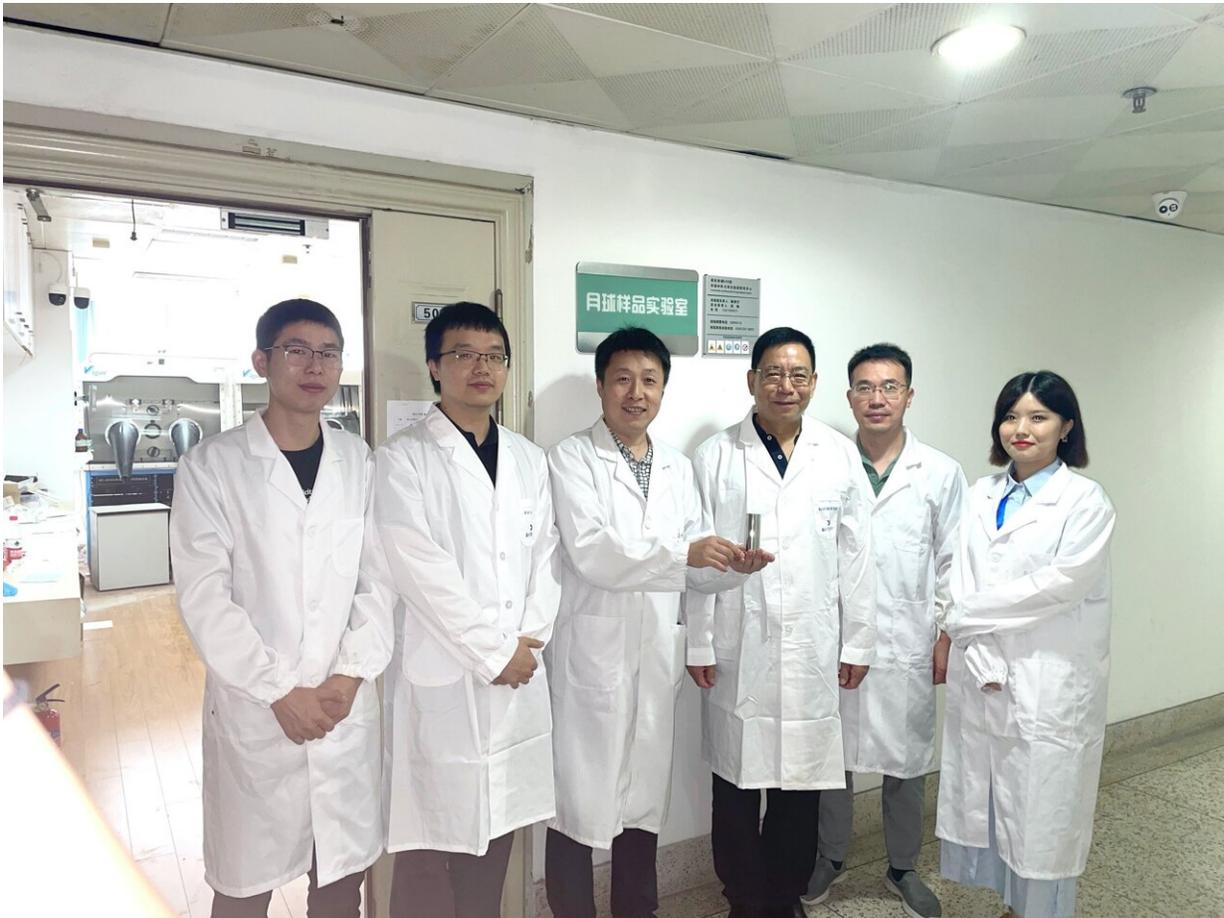
"We use in-situ [environmental resources](#) to minimize rocket payload, and our strategy provides a scenario for a sustainable and affordable extraterrestrial living environment," Yao says.

While the catalytic efficiency of lunar soil is less than catalysts available on Earth, Yao says the team is testing different approaches to improve

the design, such as melting the [lunar soil](#) into a nanostructured high-entropy material, which is a better catalyst.



This schematic shows how lunar soil can work as a catalyst for extraterrestrial photosynthesis to make oxygen and fuels needed for long-term survival on the moon. Credit: Yingfang Yao



This photograph shows the research team at Nanjing University holding the lunar soil sample. Credit: Yingfang Yao

Previously, scientists have proposed many strategies for extraterrestrial survival. But most designs require energy sources from Earth. For example, NASA's Perseverance Mars rover brought an instrument that can use [carbon dioxide](#) in the planet's atmosphere to make oxygen, but it's powered by a nuclear battery onboard.

"In the near future, we will see the crewed spaceflight industry developing rapidly," says Yao. "Just like the 'Age of Sail' in the 1600s when hundreds of ships head to the sea, we will enter an 'Age of Space.'

But if we want to carry out large-scale exploration of the extraterrestrial world, we will need to think of ways to reduce payload, meaning relying on as little supplies from Earth as possible and using extraterrestrial resources instead."

More information: Zhigang Zou, Extraterrestrial photosynthesis by Chang'E-5 lunar soil, *Joule* (2022). [DOI: 10.1016/j.joule.2022.04.011](https://doi.org/10.1016/j.joule.2022.04.011). [www.cell.com/joule/fulltext/S2542-4351\(22\)00178-7](https://www.cell.com/joule/fulltext/S2542-4351(22)00178-7)

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