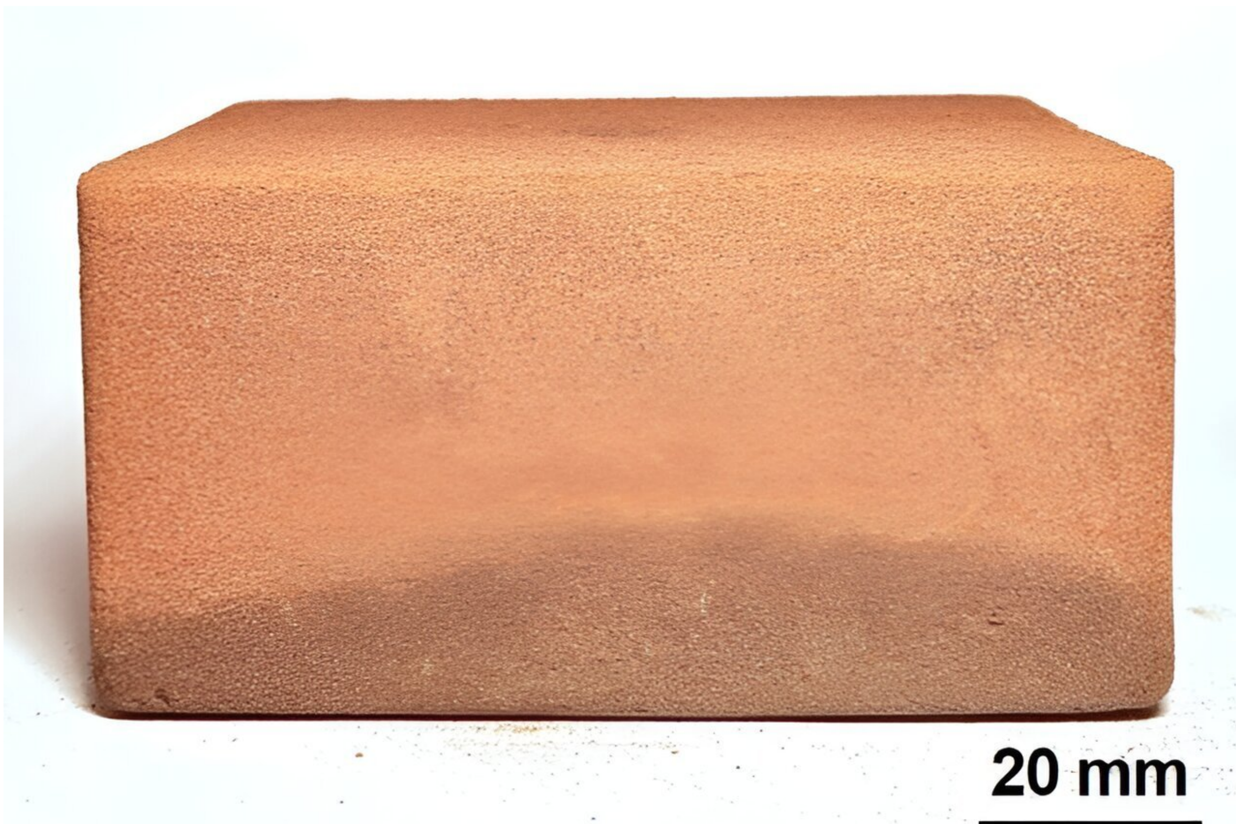
Using microwave sintering to produce 'space brick' for a future moon base

July 10 2024



Photograph and X-ray CT image of KLS-1 sintered block manufactured using an optimized process. Credit: Korea Institute of Civil Engineering and Building Technology

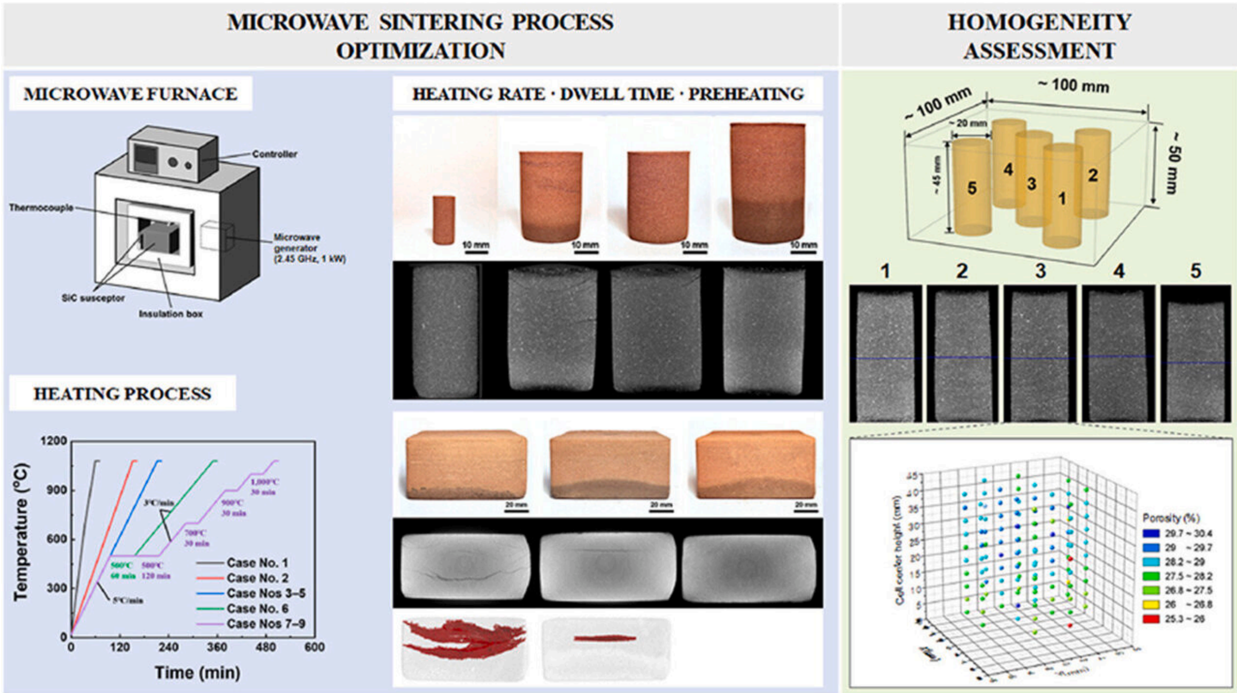
The recent discovery of energy resources on the moon, such as water ice, has refocused interest on its potential as a sustainable hub for space exploration. NASA has also announced the Artemis mission, aiming for long-term human presence on the lunar surface. However, infrastructure expansion, such as lunar base construction, plays a vital role.

Yet, transporting construction materials from Earth to the lunar surface via landers incurs a significant cost of 1.2 million USD per kilogram. Weight directly translates to cost, making the transportation of construction materials from Earth to the moon nearly impossible.

To address this problem, Korea Institute of Civil Engineering and Building Technology, has developed technology for producing construction materials using in-situ resources from the moon. The study is published in the *Journal of Building Engineering*.

The most readily available in-situ resource on the moon is lunar regolith, which is the moon's surface soil. Utilizing lunar regolith can lead to cost savings. Composed of fine particles, lunar regolith can be sintered through heat. However, in space environments, energy efficiency considerations are crucial for applying heat. And Microwaves are particularly advantageous in terms of energy efficiency.

The research team (Dr. Jangguen, Lee, Dr. Young-Jae, Kim, Dr. Hyunwoo, Jin) led by Dr. Hyu-Soung, Shin at the Future & Smart Construction Research Division of KICT, utilized microwave sintering to produce blocks from lunar regolith simulant by heating and compacting it.



Graphical abstract. Credit: *Journal of Building Engineering* (2024). DOI: 10.1016/j.jobe.2024.109193

When using microwaves to heat lunar regolith, localized hot and cold spots can form. These spots lead to localized thermal runaway, hindering uniform heating and sintering. To address this, a stepwise heating program with specific temperature and dwell time was established.

Additionally, lunar regolith contains volatile substances, including water. Heating these volatile materials can cause internal cracks during sintering. The research team mitigated crack formation by using preheated lunar regolith simulant under vacuum conditions at 250°C.

To assess the completeness of sintered blocks intended for construction materials, the produced blocks were core-drilled at specific locations. The average density, porosity, and compressive strength of the core-drilled samples were approximately 2.11 g/cm^3, 29.23%, and 13.66 MPa, respectively. The corresponding standard deviations were 0.03, 1.01, and 1.76, confirming the homogeneity of the sintered blocks.

KICT has secured technology for producing construction materials using lunar regolith. The plan is to validate this technology in space environments. By verifying it under space conditions, we can better address the increasing demand for space construction technology.

Dr. Shin said, "Many previous space construction studies related to microwave sintering technology have resulted in small or heterogeneous sintered bodies." He further expressed plans to utilize this technology for various infrastructure construction needs on the lunar surface in the future.

More information: Hyunwoo Jin et al, Optimized manufacturing process of homogeneous microwave-sintered blocks of KLS-1 lunar regolith simulant, *Journal of Building Engineering* (2024). DOI: 10.1016/j.jobe.2024.109193

Provided by National Research Council of Science and Technology