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Binder-Free Laser 3D Printing Turns Simulated Moon Dust Into Interlocking Lunar Bricks

Space & Astronomy * Natural Science * Research Dispatch

Engineers at the University of Arkansas have developed a 3D-printing process that fuses simulated moon dust into sturdy, interlocking LEGO-like building blocks without adding any glue, cement, or chemical binders. Published in npj Advanced Manufacturing by Cole McCallum, assistant professor of mechanical engineering Wan Shou, and colleagues, the technique uses a focused laser to sinter Lunar Highlands Regolith Simulant (LHS-1) directly into modular cross-shaped and H-shaped bricks that can be snapped together and reconfigured for future lunar habitats.

Shipping conventional construction materials from Earth to the Moon is extraordinarily expensive because every kilogram launched into lunar orbit demands massive amounts of rocket propellant. Finding practical ways to build landing pads, radiation shields, and pressurized base foundations out of native lunar soil -- an approach known as in-situ resource utilization (ISRU) -- is essential for sustained human exploration.

How Binder-Free Laser Powder Bed Fusion Works

The team used a 3D-printing method called laser powder bed fusion, in which thin layers of fine mineral powder are spread across a build platform and selectively heated by a scanning laser beam. Rather than melting the dust with added plastics or hauling liquid chemical binders from Earth, the researchers tuned a relatively low-power light source to sinter the simulated regolith grains -- heating particle surfaces just enough to fuse neighboring mineral grains directly to one another.

For the feedstock, the researchers worked with Lunar Highlands Regolith Simulant (LHS-1), a standardized terrestrial mineral mixture formulated to match the chemical and particle-size properties of highland soil samples returned during the Apollo missions. Eliminating external binders removes a major logistical bottleneck: astronauts would only need solar-powered laser hardware and local lunar dust scooped from the surface.

| Manufacturing Parameter | | Research Specification | | Advantage for Lunar Operations |

| Feedstock Material | | Lunar Highlands Regolith Simulant (LHS-1) | | Replicates Apollo-era highland lunar dust locally |

| Fabrication Method | | Laser powder bed fusion (direct sintering) | | Uses a relatively low-power light source |

| Binder Requirement | | Zero added chemical or polymer binders | | Eliminates shipping mortar or resin from Earth |

| Block Geometries | | Modular cross-shaped and H-shaped bricks | | Allows mortarless assembly and reconfigurable walls |

Why Interlocking Modular Bricks Beat Monolithic Walls

Instead of printing a single giant, rigid wall in place, the University of Arkansas team printed discrete, interlocking geometries -- such as cross-shaped and H-shaped blocks -- designed to lock together mechanically like toy building bricks. Modular interlocking blocks offer a major operational advantage on the Moon: structures can be assembled without wet mortar (which cannot cure normally in a vacuum), disassembled if a base layout changes, and repaired simply by swapping out damaged pieces.

Modular masonry also tolerates the Moon's extreme thermal swings. Lunar surface temperatures plunge far below freezing during the two-week lunar night and soar above the boiling point of water during the two-week lunar day, causing materials to expand and contract repeatedly. Discrete interlocking joints can accommodate slight thermal shifting without cracking the entire structure.

Next Steps Toward Off-World Construction

Before laser-sintered regolith bricks can support crewed Artemis-era outposts, engineers must test how the printing process performs under true lunar vacuum conditions and one-sixth Earth gravity, where fine electrostatic dust behaves differently than it does in terrestrial laboratories. Scaling up throughput and measuring long-term resistance to micrometeorite impacts and thermal cycling will also be critical.

Even with those engineering steps ahead, proving that simulated Apollo highland dust can be laser-fused into precision interlocking blocks without imported binders marks a practical milestone toward building durable, reconfigurable infrastructure directly on the lunar surface.

References & Primary Sources

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