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MULTI-COMPONENT BINDER ENHANCED INDIRECT LUNAR REGOLITH MANUFACTURING TECHNOLOGY FOR ON-SITE LUNAR CONSTRUCTION UNDER EXTREME LUNAR ENVIRONMENT

Abstract

A new wave of lunar exploration activities is emerging globally. The development of in-situ lunar manufacturing technology can effectively support the construction of lunar bases, payload protection structures, and astronomical observation facilities, ensuring long-term human activities on the Moon. This paper proposes a novel in-situ manufacturing technology based on lunar regolith and multi-component resin composites. By mixing simulated lunar regolith with photosensitive resin, thermosensitive resin, and specific additives into a paste-like material, this system enables various forming processes including photocuring, compression molding, and extrusion molding. The material exhibits self-curing properties under UV irradiation and lunar high-temperature conditions while significantly reducing energy consumption. This study focuses on extrusion forming experiments using this material system, developing large-scale printing equipment to achieve meter-scale 3D structural printing. Comprehensive evaluations were conducted on printed specimens including morphological characteristics, mechanical properties, thermal insulation performance, and serviceability under extreme lunar environments. Experimental results demonstrate high mechanical strength (compressive strength higher than 31.48 MPa) and excellent thermal insulation (thermal conductivity lower than 0.684 W/(m·K)). Moreover, the technology shows strong tolerance to vacuum conditions, thermal cycling, and UV radiation, making it particularly suitable for future in-situ lunar base construction with promising applications in lunar exploration and resource utilization.