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Topic of Research: Studies on Laser Based Additive Manufacturing of Biocompatible Metal Alloys for Biomedical Implants

Findings

- In this study, as per Taguchi L9 orthogonal matrix experiment (Run 7), results in maximum relative density of 99.6% among the manufactured specimens. Sample C7 demonstrated excellent material consolidation and low porosity. The parameter settings used to achieve this optimal outcome are as follows: Laser Power, 200 W; Scanning Speed, 800 mm/s; Hatch Distance, 100 μm; Layer Thickness, 45 μm. The results indicate that high laser power and lower scanning speeds produce ideal thermal conditions for the complete melting and fusion of powder particles, thereby increasing relative density.
- Based on statistical analysis using Taguchi L9 and One-Way ANOVA, the order of significance among the LPBF process parameters was determined as: Laser Power (LP) > Scanning Speed (SS) > Hatch Distance (HD) > Layer Thickness (LT).
- Microstructural analysis of three selected samples (C2, C7, C9) revealed that Sample C7 exhibited excellent microstructure with minimal defects, low surface roughness, reduced porosity, and excellent strut uniformity. The maximum relative density of 99.6% was observed for sample C7.
- Compression testing revealed a mean compressive strength of 177.3 MPa for the optimised LPBF-fabricated Ti6Al4V samples. This value falls within the typical range of human cortical bone (130–230 MPa), indicating that the material possesses sufficient load-bearing capacity. These results confirm the potential of Ti6Al4V for use in orthopaedic implants, where mechanical compatibility with bone is crucial for long-term performance and patient safety.