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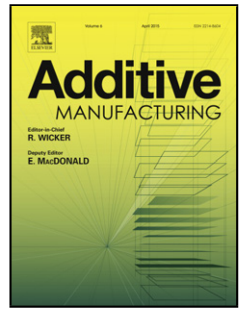

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Micromechanical analysis of the effective properties of lattice structures in additive manufacturing

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Abstract

Lightweight design is an area of mechanical engineering that becomes increasingly important in many industries, as they pursue reduced mass and more efficient parts. A special class of materials for load-bearing structures are metallic cellular materials with cubic unit cells, which can be manufactured conveniently through laser beam melting (LBM). Such materials exhibit a rather complex microstructure and can be analysed using analytical and numerical methods wherein the determination of properties such as relative density, effective elastic and yield strength properties is of special interest. This paper addresses closed-form analytical methods based on beam theories for the determination of the effective properties of additively manufactured microstructures such as lattices, and a comparison with experimental results [1, 2] which leads to excellent agreements for relative densities lower than 40%, although results reveal a great dependency on the manufacturing strategy. Lastly, a classification concerning the topology of the cellular units is presented as well in order to help the engineer choose appropriate geometries for specific application purposes. In conclusion, this structural concept may be applied in many fields such as bioengineering and in functional graded materials as they are applied in lightweight engineering.

Keywords: Additive Manufacturing, Cellular Solids, Lattice Structures, Lightweight Design

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