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Topology Optimized Design for Additive Manufacturing

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Abstract: *Additive manufacturing (AM) has evolved into a disruptive technology enabling the production of lightweight,complex, and customized components across aerospace, automotive, biomedical, and energy industries. Conventional manufacturing often limits structural optimization due to tooling and geometric restrictions, whereas AM offers unprecedented design freedom. Among the strategies for lightweighting, topology optimization (TO) has emerged as a superior method compared to lattice structuring, as it systematically distributes material in accordance with applied loads and constraints. This paper presents a comprehensive study on topology-optimized design for AM, highlighting recent advances up to 2025. The discussion covers the classification of AM processes, their suitability for topology-optimized designs, and the role of support structures in manufacturability. Emerging trends such as space–time topology optimization, AI-assisted algorithms, hybrid lattice-TO approaches, and multi-scale optimization are emphasized. Applications in aerospace brackets, automotive suspension systems, orthopaedic implants, and energy-efficient heat exchangers are reviewed. The findings suggest that topology optimization, when integrated with advanced AM technologies, provides the most effective pathway to achieving lightweight, high-performance, and sustainable designs.*

Keywords: Additive Manufacturing, Topology Optimization, Design for AM, Lightweight Structures, Selective Laser Melting, Electron Beam Melting

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