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**A Study of Design Optimization and 3D Prototyping for Embedded
Non-Metallic Components**

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ABSTRACT

Design optimization and 3D prototyping for embedded non-metallic components play a crucial role in enhancing manufacturability, structural performance, and product reliability. Non-metallic materials such as polymers, composites, and advanced resins are increasingly used in engineering applications due to their lightweight properties, corrosion resistance, and cost-effectiveness. However, embedding these components within larger assemblies presents challenges including dimensional inaccuracy, material shrinkage, weak bonding interfaces, and thermal deformation. Design optimization techniques, supported by Computer-Aided Design (CAD) and simulation tools such as Finite Element Analysis (FEA), help refine geometry, wall thickness, and material distribution to improve structural stability and compatibility. The integration of 3D prototyping, particularly additive manufacturing technologies like stereolithography (SR), enables rapid fabrication of complex geometries with high precision and surface quality. Iterative prototyping allows engineers to evaluate tolerance fit, assembly alignment, and mechanical performance before final production. This approach reduces development time, minimizes material waste, and identifies potential manufacturing defects at an early stage. Furthermore, optimized designs improve bonding strength and ensure better integration of non-metallic components within embedded systems.