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The design of medical implants involves multiscale consideration. The structure in macro level needs to satisfy the space, functional, aesthetic and load-transfer requirements. Additional considerations of stress-shielding and localized stress-concentrations to improve the effectiveness and functionality can be increased using architectured metamaterials. For example, the mechanical properties of the bone implants and their adjacent bone need to be similar to reduce these effects. Topology optimization is a numerical tool that is suitable for obtaining optimized geometries under several constraints. Earlier efforts used inverse homogenization technique to attain the microstructures of scaffold geometries. These equivalent material model would be valid when there is a significant dimensional difference between the large and the small scales. With recent advances, 3D printing of multiscale multi-material structures is realizable. We present an approach to design tunable architectured metamaterials for implants which may alleviate localized stress-concentration and stress-shielding. We develop a topology optimization framework to design the architecture materials in different scales which varies smoothly within the design domain. The preliminary study shows easy control in connectivity and provides more topological variability. The metamaterial implant models designed using the methodology in this work are 3D printed, and their performance is studied using mechanical testing.

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