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DESIGN OPTIMIZATION OF DENTAL IMPLANT USING ADDITIVELY MANUFACTURED LATTICE MATERIALS

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Summary: A Dental implant is a biocompatible surgical component placed into the jawbone to support dental prosthesis including bridges, crowns, or denture replacements. It might also be used in facial prosthesis operations or orthodontic anchoring.
Currently, dental implants are constructed employing solid materials, coated with biocompatible layers. Since bone is a living tissue which is constantly modified in response to external loading, redistributed or reduced mechanical loading might cause bone resorption, implant loosening or interface failure, all of which have been notable problems for orthopedic implants. To address these issues, this paper presents a novel design for dental implant employing lattice materials. A lattice material is a class of open cell engineered cellular solid that is periodically structured and optimized for different applications. A multiscale and multi-objective design optimization framework based on Finite Element Method was constructed to, primarily, minimize the bone/implant interface failure and bone loss and secondary, to minimize the implant weight. Here, we assumed the implant as made of a lattice part (interface zone with the bone) and a solid part (implant core). The design variables included the microscopic parameters of the lattice unit cell as well as thickness of the interface zone. Simulation results show that the proposed design is capable of reducing the interface failure and the bone loss. Additively manufactured Titanium Ti-6Al-4V, a biocompatible material, is used for the new implant manufacturing, eliminating the need for a biocompatible coating.