# Design of 3D printed Dental Implants by Using Response Surface and Topological Optimization Methods

Yu-Chieh Tsai[1*], Hou-Yung Cheng[1], Nien-Ti Tsou[1]

[1]*Department of Materials Science and Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan*

Recently, 3D printed dental implants has been of interest in both academy and industrial fields. The flexibility of 3D printed geometry may reduce the stress shielding effect. This allows the bones under the adequate range of stress, preventing from severe resorption. Several design guidelines for the dental implants have been proposed in the literature, and yet, mainly focused on the implants manufactured by the traditional machining techniques. In the current work, four design parameters: implant length, implant radius, thread radius and thread top length were used to generate 1155 different implants, and the corresponding performances were predicted by mechano-regulation algorithm. The response surface method was used to obtained the optimized implant. Then, this implant was used as the initial state of another topological optimization procedure. As the shape of implant is constructed element by element, the implants are suitable to be manufactured by 3D printing techniques. The resulting implants allow the surrounding bone to maintain in best physiological range under the given applied loads and boundary conditions. The performance of the implant was also examined by the mechano-regulation algorithm, showing that the shielding effect is minimized. The results of the current work can extend the knowledge of the field of biomechanics, as well as enhance the development of the industry in medical engineering.

**Keywords:** Biomechanics, Finite element method, response surface methodology, topology optimization