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# Multiscale optimization of porous implants with a Voronoi based microstructure

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One of the most important problems with bone implants is their long-term stability. Implant failure is mainly due to bone resorption resulting from stress shielding, which arises from the mismatch of mechanical properties between the implant and the surrounding bone. This work extends the multiscale optimization method for the design of solids introduced by Colabella et al. [1] to the design of bone implants whose properties are adjusted according to structural, permeability and morphological requirements using the Voronoi-based microstructure first introduced by Fantini et al. [2].

The microstructure is built using a generative design approach, the Voronoi tessellation approach. To verify the aptitude of the microstructures to reproduce the trabecular bone behavior, the elastic properties and permeability obtained using the Fast Fourier Transform (FFT) method developed by Colabella et al. [3] were compared with natural bone data. It is concluded that the Voronoi-based microstructure is effective to mimic the solid volume fraction, the trabecular thickness, and the bulk and shear moduli of the natural bone.

The performance of the method is evaluated by solving a problem consisting in finding the optimal distribution of microstructures for a proximal end of a femur subjected to physiological loads. The model successfully predicts the main features of the spatial arrangement of the trabecular and cortical microstructures of the natural bone.

## REFERENCES

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