MICROPOLAR ELASTIC MULTI-LAMINATE COMPOSITES AND THE BIOINSPIRED INTEGRATION FOR ENHANCED BONE RECONSTRUCTION

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The two-scale asymptotic homogenization method is applied to find the effective properties of periodic laminated Cosserat media with centro-symmetric phase constituents. Both perfect and imperfect interface contact conditions are considered. Imperfect interfaces are defined when tractions and normal stress are continuous but displacements and microrotations are discontinuous across the interface between phases. The jumps in the displacement and microrotation components are proportional to their respective interface traction and normal stress components in terms of a partition of different spring-factor-type interface parameters. Series expansions are developed as a function of micro-macro structures for the displacement and microrotation fields. The local problems are stated and solved; the effective properties are written as a function of the volume fractions of the phases, the constituents material properties, and the imperfection parameters. Numerical results are analyzed for a bi-laminated Cosserat composite considering partitions of multiple interface imperfections with different ranges for the imperfection parameter values. Fibonacci structures under perfect contact adhesion are also analyzed. The effects of imperfections and the rotations of the constitutive materials properties of each layer on the effective properties are described. Furthermore, considering the micropolar media's prevalence in bio-inspired systems, the model's applicability is evaluated for reconstructing bone fractures using multi-laminated bio-composites. An important finding in this bio-inspired simulation is related to the analysis of a periodic bi-laminated micropolar composite whose isotropic constituents are a bio-ceramic material and a compact bone. This artificial bio-inspired material should integrate with host tissue to support cell growth, be stable and compatible. These characteristics are crucial in the enhancement of the fractured bone.

Keywords: Homogenization, Cosserat media, composite materials

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