Abstract

This work is devoted to the use of optimization methods to obtain structures characterized by a minimal and maximal Poisson ratio. The initial part of the work describes the definition of optimization, types of auxetic metamaterials, examples of their applications and occurrence in nature. A literature review concerning the history of auxetics and the using of topology optimization methods in the field of structure design was made. The optimization process in this work is carried out by filling a domain with two materials with real materials' properties (Young's modulus, Poisson's ratio). The optimization areas were: the core layer of the square-shaped composite, the hexagonal and re-entrant structure of the honeycomb, and the anti-tetra-chiral structure. The optimization was made with the goal of minimizing and maximizing the Poisson ratio to obtain appropriate displacements in the transverse direction. Obtaining a Poisson's negative coefficient leads to characteristic properties of auxetic metamaterials. In the work, the final results were calculated based on: Finite Element Methods, SIMP and RAMP interpolation schemes leading to the computing of the final effective material properties, as well as the MMA algorithm to search for the optimal value of the objective function. All simulations were carried out using the COMSOL Multiphysics software. Optimizations in the domains were made for different values of Poisson's ratios and Young's modulus of two filling materials, with different percentages of material with a higher Young's modulus in the whole geometry and different geometrical parameters of the optimized domain. The optimization results were also compared with different types and densities of mesh in the Finite Element Methods. The work also presents the results of optimizations using the SIMP and RAMP interpolation schemes. In the final chapters of the work, the results were compared with different values of the above mentioned parameters.