Abstract

The aim of this work was to develop a method for optimizing both design parameters and mechanical properties of polymer based nanocomposites using numerical multi-objective optimization (MOO) methods. The main objective was to simultaneously maximize the elastic modulus and the tensile strength of nanocomposites. The rationale behind focusing on these particular properties is that they play a significant role in designing of materials for structural applications. Ji and Zare models of determining the elastic modulus and tensile strengths of polymeric nanocomposite materials were respectively used for the formation of the objective functions for numerical optimization. The design variables (i.e major factors affecting the given mechanical properties) were identified as the diameter of nanofillers, thickness of the interphase region, nanofillers loading as weight fraction, elastic modulus of the interphase, interfacial shear stress and the orientation factor of the nanofillers. The Fast Non-dominated Sorting Genetic Algorithm (NSGA-II) approach in MATLAB was used to maximize the objective functions by obtaining the optimum solutions of the given design variables. The optimization model was able to successfully find optimum solutions of the design variables. Furthermore, the overall optimization results were found to be in good agreement with the available experimental results from literature. The proposed optimization model was found to be significantly accurate in finding the optimum values of the design variables for improving the mechanical properties of nanocomposites. The optimum values of the design variables were determined to be 2.12 - 2.96 nm for the thickness of the interphase, 5.41 - 7.01 nm for the diameter of the nanofillers, 2.95 - 4.69 wt.% for the nanofillers loading, and 1 for the nanofillers orientation factor. In addition, the results further showed that nano-reinforcements such as multi-wall carbon nanotubes (MWCNTs) yields high elastic modulus of the interphase and interfacial shear stress.