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Prediction of elastic modulus for polymer composites

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Abstract

© Research India Publications.Elasticity of the composites was analyzed as inhomogeneous systems and their predictive estimation was provided using relevant models by Eshelby, nonlinear patterns of elastic de-formation of bodies with rigid inclusions (Einstein, Guth-Smallwood, Eilersvan Dijck, Kerner, Mooney, Halpin-Tsai, Nielsen, Ishai equations). With the Shklovsky-De Gennes model the topological model was obtained in order to deter-mine the fractal dimension of particulate filled polymer composites. The critical concentration of particulate filler in polymer composites was updated (percolation threshold υ=0, 15) to reveal a structural transition from isolated clusters to a skeleton lattice which consists of dispersed particles and polymer film matrix. Using the percolation theory a value of critical exponent t3 (universal exponent for state of structural topology of particulate filled polymer system) was found and defined. The universal critical exponent t3=1, 58 was found, it determines a skeleton of fractal percolation cluster from fractal point of view, and it was revealed to have a pivotal effect on increasing the elasticity of composite materials. The pre-diction mathematical models (polynomial, exponential, etc.) were obtained for dynamic modulus and impact resistance of epoxy, polyether, epoxy-polyurethane composites according to the concentration of different hardeners. The optimum concentrations of matrix components (hardeners, modifiers) which provide high elasticity and impact resistance of the polymer matrices under study were defined. Based on the Kelvin-Voigt model a new structural mechanical model of particulate filled polymer composites was developed. It reflects the strain condition of matrix-mass, matrix-film and percolation lattice which consists of dispersed particles. With the Verhult's method the prediction models were obtained to describe the change in dynamic modulus according to volume content of reinforcing fillers. A two-component modifying agent was developed for epoxy-polyurethane composite materials with higher stress-strain properties. It consists of poly-ether and polyisocyanate in a ratio of 1 to 1. The formulas of effective filled epoxy, polyether and epoxy-polyurethane composites were specified.

Keywords

Elastic modulus, Percolation model, Polymer composites, Prediction