

Analytical and numerical approaches to prediction and control of the percolation threshold in disordered systems

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This paper presents a comparative analysis of leading analytical, numerical, and experimental methods for predicting and controlling the percolation threshold to establish a conceptual link between abstract network models and real physical systems, specifically, polymer nanocomposites. The analysis was performed using prediction models: the Monte Carlo (MC) method, the spectral method, and excluded volume theory. The concept of double percolation and in-situ solvothermal reduction of graphene oxide directly in the polymer matrix to achieve uniform filler distribution is considered. However, achieving the lowest possible percolation threshold may be undesirable if it compromises the structural integrity of the material. This analysis demonstrates significant progress in predicting and controlling the percolation threshold of disordered systems.

Keywords: percolation theory, disordered systems, polymer nanocomposites, Monte Carlo methods, spectral graph theory, microstructure control.

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