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Nano-rod composites: a flow strategy to control anisotropic percolation.

A variety of high performance materials and property enhancements have been established in benchmark composites. The nano-particles are high aspect ratio rods or platelets, combined with traditional materials at low (1%) volume fractions, which achieve remarkable strength, conductivity, and barrier properties. We first review homogenization predictions of the authors, and then explore percolation in the nano-particle ensemble. Each analysis relies upon theory and numerical databases for the orientational probability distribution function (PDF) of the nano-rod ensemble, as determined from the modern kinetic theory of flowing macromolecules. From detailed properties of the PDFs, we simplify volume averaged property tensors and craft a Monte Carlo approach to identify percolation thresholds. We predict control over anisotropic percolation, which can be tuned by volume fraction and flow conditions to yield 1d, 2d or 3d percolating nano-rod clusters within bulk materials. (Received September 26, 2006)