

Three-dimensional electrical percolation behaviour in conductive short-fibre composites

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The percolation behaviour and electrical conductivity in unidirectional composites made of short conductive fibres embedded in an insulating matrix were examined by Monte Carlo simulation as a function of aspect ratio, volume fraction and angle. The unidirectional composite exhibited a highly anisotropic percolation behaviour with respect to the fibre direction for both fibre normal and fixed-length distribution. For the direction parallel to the fibre, the electrical conductivity increased exponentially with the volume fraction and the exponent increased as the aspect ratio increased. The conductivity in the transverse direction exhibited a sharp transition, from zero to nearly the same level as parallel conductivity at the critical volume fraction. The percolation threshold for the transverse direction also increased with aspect ratio up to 20, above which it decreased in parabolic manner. Both the threshold volume fraction and transient increase in conductivity in the transverse direction varied parabolically with aspect ratio, the maximum being an aspect ratio of 20.