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How Round is Round? On Accuracy in Complex Dielectric permittivity calculations: A Finite-Size Scaling Approach

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Abstract: Accuracy in complex dielectric permittivity calculations in binary dielectric mixtures in two-dimensions are reported by taking into account the shape of the inclusion phase. The dielectric permittivity of the mixtures were calculated using the finite element method, and the permittivities were estimated by two different procedures. The results were compared with those of analytical models based on a mean field approximation and regular arrangement of disks. We have approached the problem emphasizing the finite-size behavior in which regular polygons with n sides were assumed to mimic the disk inclusion phase. It was found that at low concentrations, < 30%, decagon-approximated circles (n = 10) cause an error of < 0.1% in the effective medium quantities compared with results obtained using analytical models.

Key Words: Dielectric mixtures, composite materials, the finite element method, finite size scaling