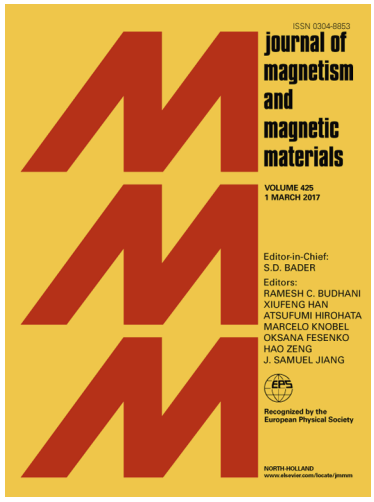

Research articles

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Percolation Behaviour in the Magnetic Permeability and Electrical Conductivity in Conducting Magnetic - Insulating Non Magnetic Binary Composites.

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Abstract: Experimental results of the complex magnetic permeability (μ) and the electrical conductivity (σ) of a granular paramagnetic Gadolinium Gallium Garnet (GGG: 0.3 to 26 Vol. %) and Teflon (PTFE) system are presented, and discussed in relation to previously published (conductivity) and unpublished (permeability) studies on granular Fe_3O_4 – talc and Ni – talc wax systems. In these systems, plots of the real conductivity (σ'_m) against the volume fraction (φ) lie on characteristic sigmoid curves that when fitted to the Two Exponent Phenomenological Percolation Equation (TEPPE), confirm the existence of "percolation microstructures" with critical volume fractions (φ_c). The plots of the real and imaginary permeability (μ'_m) and (μ''_m), satisfactorily fit to the TEPPE using the φ_c obtained in each case from the "conductivity" measurements. In all three cases, the conductivity results gave the exponent $t > 2$, and the permeability results gave $t < 1$.

Introduction: A theoretical understanding of the physical properties, being the complex conductivity (σ), complex dielectric constant (ε), complex permeability (μ), thermal conductively (κ), and diffusivity (D) of various binary composites in relation to the volume fraction φ and topology of each component is of fundamental and practical interest. Published analytical expressions for these properties have evolved from early mixing rules[1-3] through Effective Media Theories (EMT)[1-3] and later percolation models[4,5]. The Single Exponent Phenomenological Percolation Equation (SEPPE) or General Effective Media Equation (GEM)[3] was first derived and published in 1986, and is still in current use. The Two Exponent Phenomenological Percolation Equation[6,7] (TEPPE), first published in 1997, reduces to the percolation equations[4,5] in the limits where φ approaches 0 and 1, and also when φ is close to φ_c. In the present work, new DC and low frequency permeability data are fitted to the TEPPE, and the percolation exponents *s* and *t* were obtained (using both the SEPPE (GEM) and TEPPE). Similar data which previously appeared in a thesis[8] was also analysed. By usual convention, the volume fraction of the component with the higher value of the property of interest was explicitly expressed and was designated by φ.