Experimental investigation of the correlation between particle surface smoothing and soft magnetic compact's properties

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The study provides insight into the potential of particle surface smoothing for the development and optimization of the production of soft magnetic composites, which could lead to further innovations in the field. The fabrication of magnetic materials using specialized techniques has been employed for decades, allowing the production of more precise magnetic and electrical circuits with improved energy efficiency. Despite existing knowledge, there remain unexplored areas within this domain.

This research sought to explore the properties of soft magnetic composites composed of iron particles with smooth and non-smooth surfaces. Commercial 1 mm-2 mm iron granulates with a purity of 99.98% were milled to the desired powder fractions (63 µm-125 µm and 200 µm-400 µm) and thermally processed, then divided into two groups; the first mechanically smoothed, and the second served as the reference. Using hot isostatic method, the powders were pressed into toroidal ring-shaped compacts and annealed.

In both compacts (smaller and larger powder sizes based), smoothing results in increased porosity; by 0.3% and 1.2%, respectively. The peak value of the real part of complex relative permeability rose by 13 - to 86 when 63 µm-125 µm powder fractions were used and remained around 188 for those created from 200 µm–400 µm. The peak value of the imaginary part of complex relative permeability increased by 4 (to 29) and 60 (to 170) for the two experimental scenarios. The relaxation frequency decreased by 140 Hz (to 990 Hz) for the first compacts group and went up by 15 Hz (to 130 Hz) for the second; the coercivity dropped by 180 A/m (to 1080 A/m) and 20 A/m (to 324 A/m). AC loss measurements in a 0.5 T field showed a drop of 5.6% and 3.8% (smaller and larger powder based) at 950 Hz; and by 8% and 5.7% on average over all measuring frequencies (0 Hz–950 Hz). In the 1 T field, losses decreased by 5.2% and 6.2% at 950 Hz; and by 10.7% and 5% on average over all measuring frequencies.

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