Exploring Magnetic Materials for Microwave Use

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Brief Synopsis: During my internship at the Rogers Corporation I was placed in the Advanced Circuit Materials Division under the direction of Dr. Allen F. Horn III and with the mentorship of Patricia LaFrance, who has worked in the that division of the Research & Development team for 15 years. My official project for the summer was to compare microwave properties of polymer composites containing nano-s and micro-sized fillers with the end goal of impedance matching. The fillers used were micro-sized iron particles and nano-sized Polyvinylpyrrolidone (PVP)-coated iron particles. The large surface area to volume ratio of nano-sized iron makes it extremely flammable, which is why the PVP coating was necessary. The iron particles were placed, with various vol-% loadings, in to one of the RO 4000 line polymers and tested in a new microwave measurement system. Samples were made via a solvent blending process by first mixing particle powder with the RO 4000 resin and xylene, then sonicating for 1 hour, and evaporating the solvent in a rotational evaporation set up. After the solvent was evaporated, each sample was passed through a 3-roll mill for 5 passes and the sample was formed using a hot press with a disk-shaped mask. Post-baking was conducted to fully cure the polymer and seal the particles in place. The scattering parameters were recorded for each sample and
results were analyzed using the Nicholson-Ross model to extract values for permeability and permittivity. From the results we were able to analyze in the given timeframe, the smallest percent-difference between the relative permeability and relative permittivity was found to be for the 20 vol-% micro-iron in RO 4000 sample. Further testing is required to confirm these preliminary results. In the process of working on this project, a sample creation procedure was optimized for the new microwave test-device.