High Frequency permeability of electroplated CoNiFe and CoNiFe-C alloys
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Summary
• CoNiFe and CoNiFe-C electrodeposited by pulse reverse plating (PRP) and direct current (DC) techniques
• We observe that magnetic losses in these alloys can be described in terms of classical Eddy current and anomalous losses associated with ferromagnetic resonance (FMR) absorption.
• A crossover from Eddy current to anomalous losses is found in CoNiFe, whereas CoNiFe-C shows only anomalous losses.

Experiment
• CoNiFe and CoNiFe-C were electrodeposited from aqueous solutions.
• Galvanic pulse reverse plating and DC plating were carried out using an averaged current density of 16 mA cm$^{-2}$.
• Plating was carried out in open atmosphere with strong mechanical stirring.
• Films were electrodeposited from fresh solutions on Si substrate with sputtered Cu seed layer cut into 5 x 5 mm$^2$.

Results and Discussion
• The permeability CoNiFe (PRP) remains almost constant $\mu_r \sim 450$ up to 30 MHz with a quality factor (Q) larger than 10.
• DC and PRP plated CoNiFe-C, show permeability of $\mu_r = 165$ and $\mu_r = 35$ with Q > 10 up to 320 MHz, respectively.
• Anomalous Losses in DC and PRP plated CoNiFe-C are associated with a Gaussian distribution of ferromagnetic resonance frequency.
• Distinct signatures of Eddy current and anomalous loss are observed in CoNiFe (PRP).
• A crossover between Eddy current and anomalous loss is also observed CoNiFe (PRP).
• Reversal permeability of CoNiFe (PRP) was found to remain constant at 450 up 30 MHz with a quality factor (Q) larger than 10.
• DC and PRP plated CoNiFe-C, show permeability of $\mu_r = 165$ and $\mu_r = 35$ with Q > 10 up to 320 MHz, respectively.
• Anomalous Losses in DC and PRP plated CoNiFe-C are associated with a Gaussian distribution of ferromagnetic resonance frequency.

Conclusions
• The incorporation of C to CoNiFe reduces Eddy current losses and increases quality factor.

Acknowledgments
This project was funded by Enterprise Ireland under the program ILRP/05/PEIG/02B