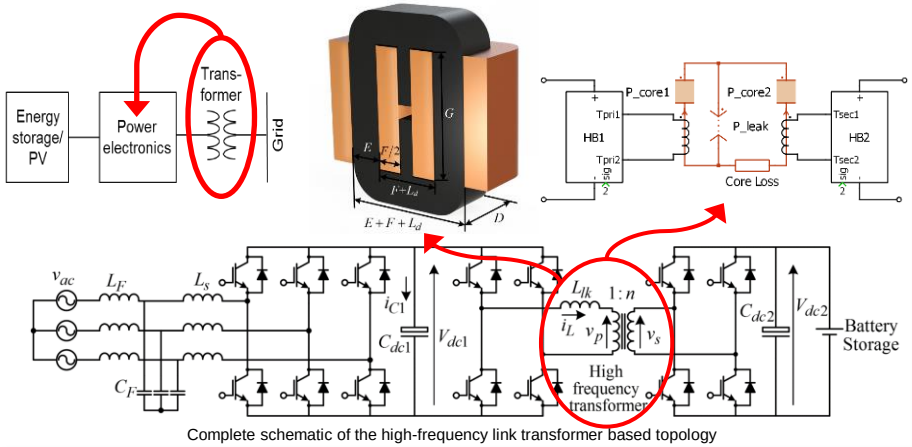
High Frequency Link Converters using Advanced Magnetics

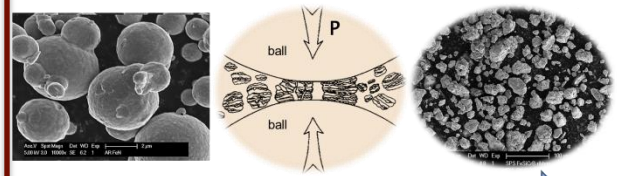
Sandia National Laboratories

Modeling and Motivation

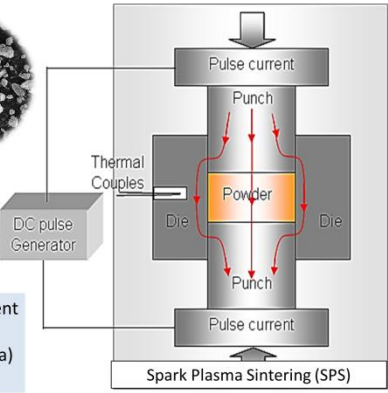


Complete schematic of the high-frequency link transformer based topology

Materials and Materials Synthesis

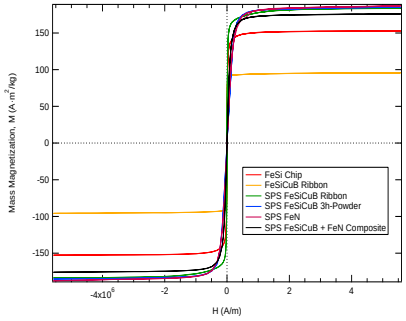


(AR) FeN Powder → Mechanical Milling → MM FeN Powder



- Both AR and MM NC FeN successfully sintered using SPS to different sized diameters (D= 5mm or 10 mm), as well as net shaped toroids
- Various temperatures and pressures used (500-600 °C, 100-350 MPa)
- Near full relative density achieved after sintering

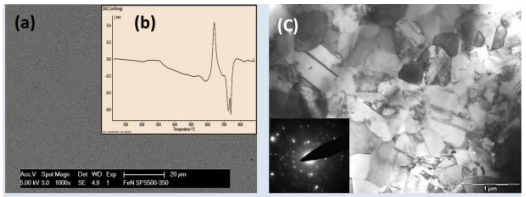
Magnetic Properties



Magnetic Material	J_s (T)	ρ(μΩ×m)
Metglas 2605SC	1.60	1.37
FINEMET (Hitachi)	1.25	1.20
VITROPERM (Vacuumschmelze)	1.20	1.15
Ferrite (Fexxocube)	0.52	$5x10^6$
α-Fe	2.15	0.05
γ'-Fe_4N	1.89	~200

- Bulk FeN has high permeability
- High magnetic saturation point (~95-190 A-m^2/kg)
- Good candidate material for transformer core in high frequency link converter

Microstructural Characterization



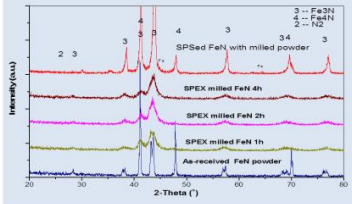


Fig. 1. (a) SEM micrograph shows fully dense FeN SPSed at 550°C, 350 MPa. **(b)** DSC of bulk FeN, with decomposition at 600°C.

(c) TEM micrograph of SPSed FeN with fine grains. **(d)** XRD of mechanically milled FeN. The diffraction peaks become broader after 1h milling, indicating grain refinement; narrowing of the peaks occurs after SPS (550°C, 100MPa).

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