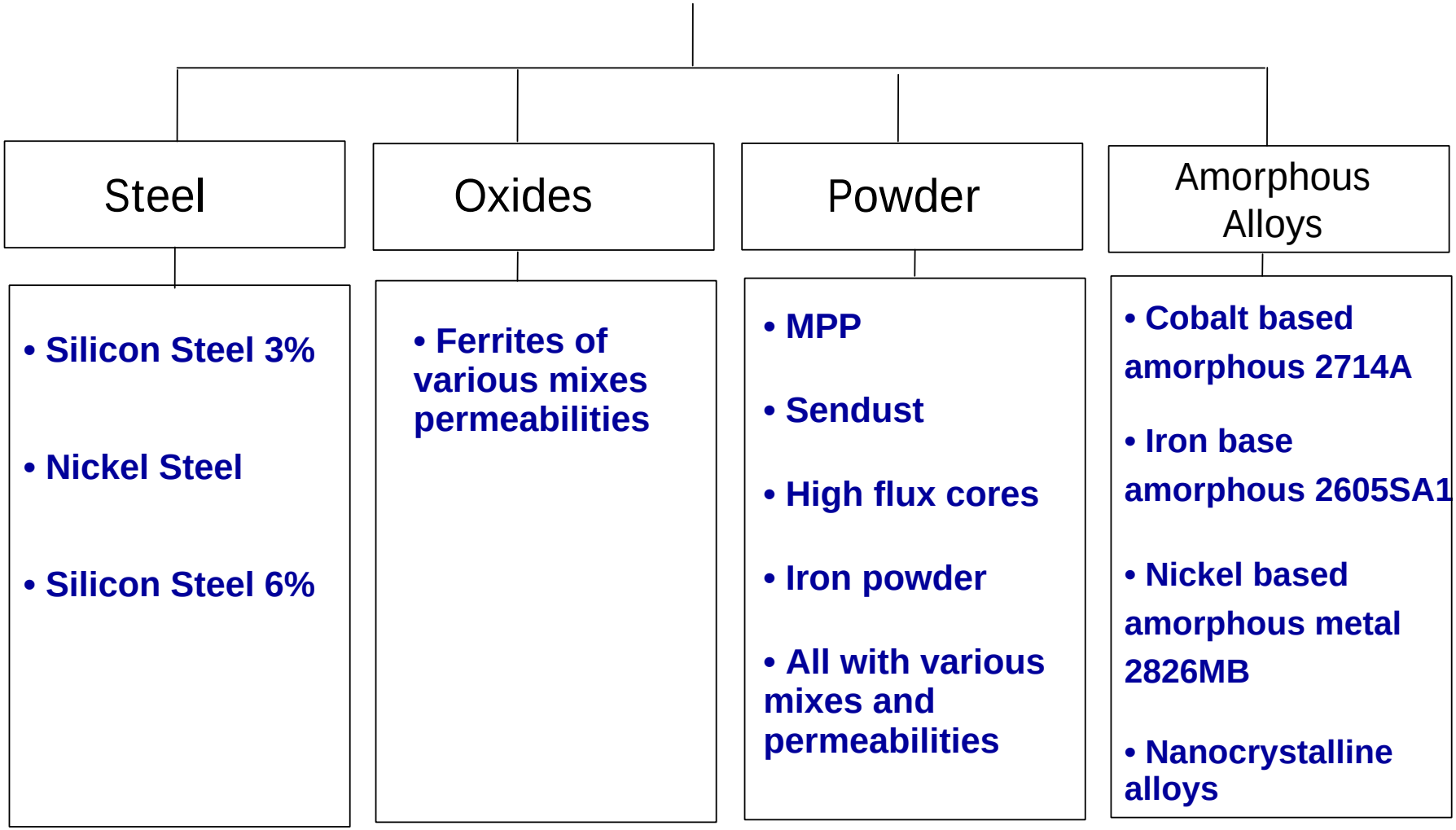
Metglas®

High-Tech Magnetic Materials vs. Performance

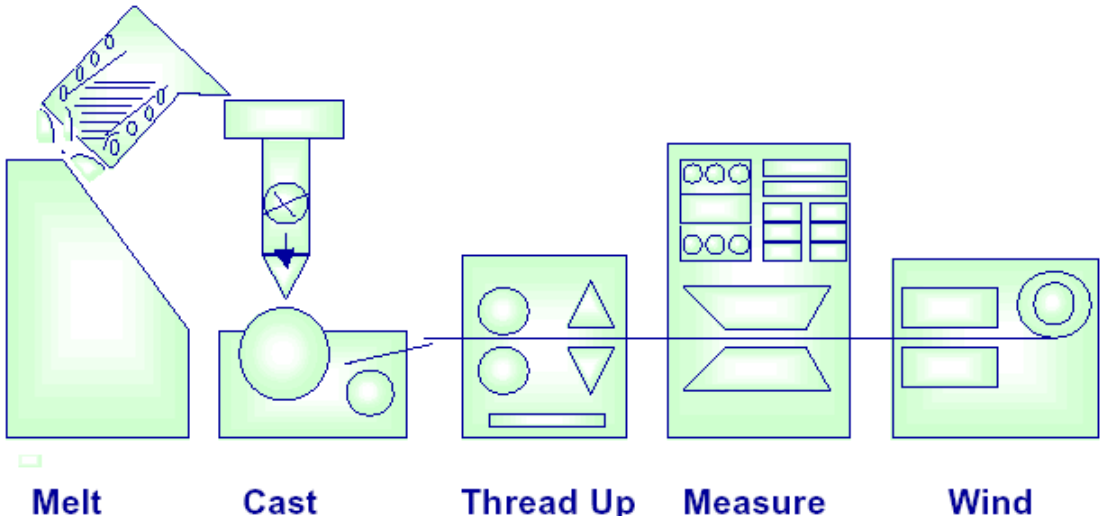
Metglas®

Soft Magnetic Materials



Metglas®

- Rapid solidification is the key to Amorphous Metal Technology
- Developed and commercialized by Metglas®, Inc.
- Capacity - 40,000 M tons/year with six casting lines in Conway, South Carolina
- Product available from multiple sources with Metglas®, Inc. licensing strategy



Metglas®, Inc. is the World Leader in Amorphous Metals Technology

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Amorphous Metals Definition

- **Metal alloys with noncrystalline atomic structures**

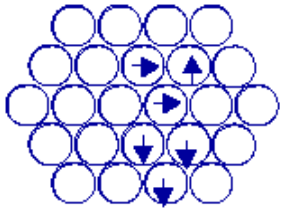
- **Product description**

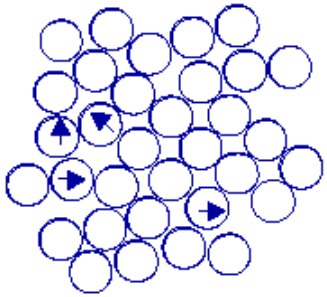
- Amorphous metal

- Glassy metal

- Metallic glass

- Metglas® alloy





Atomic Structure Is The Key To The Low Losses

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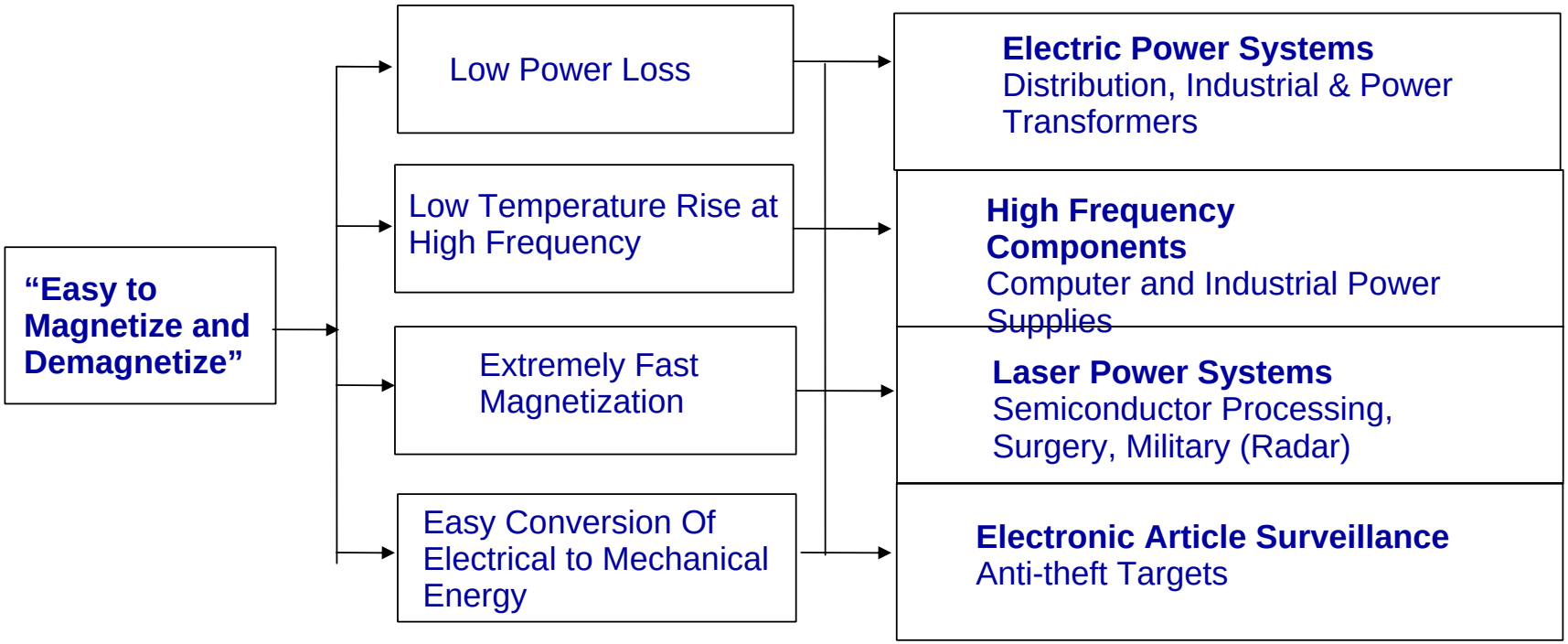
Amorphous Metals Are Unique Materials

The Key Material Attribute... → *Means Our Products Have Properties Which...* → *Provide Value In a Number of Products and Applications*



Leverage the Properties for Miniaturization of

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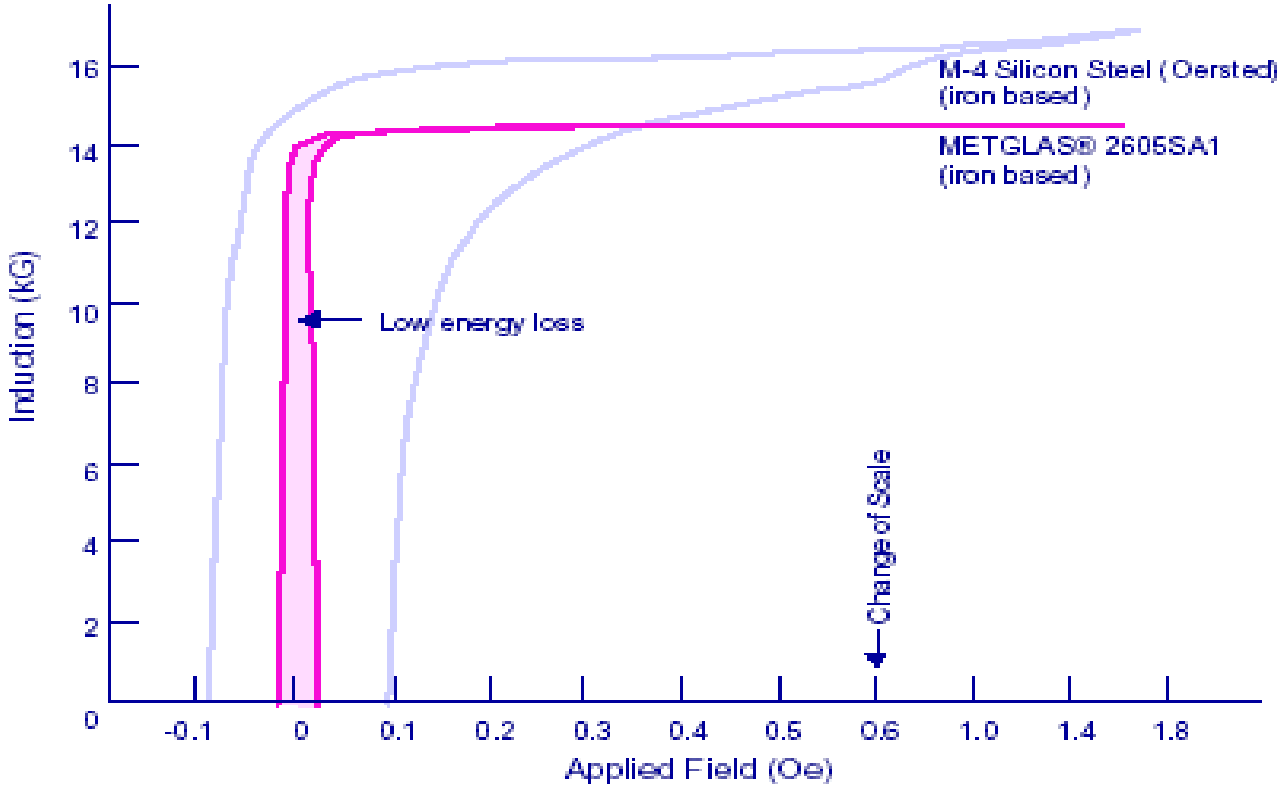
DC Hysteresis Loops



This Picture is Worth a Thousand Words

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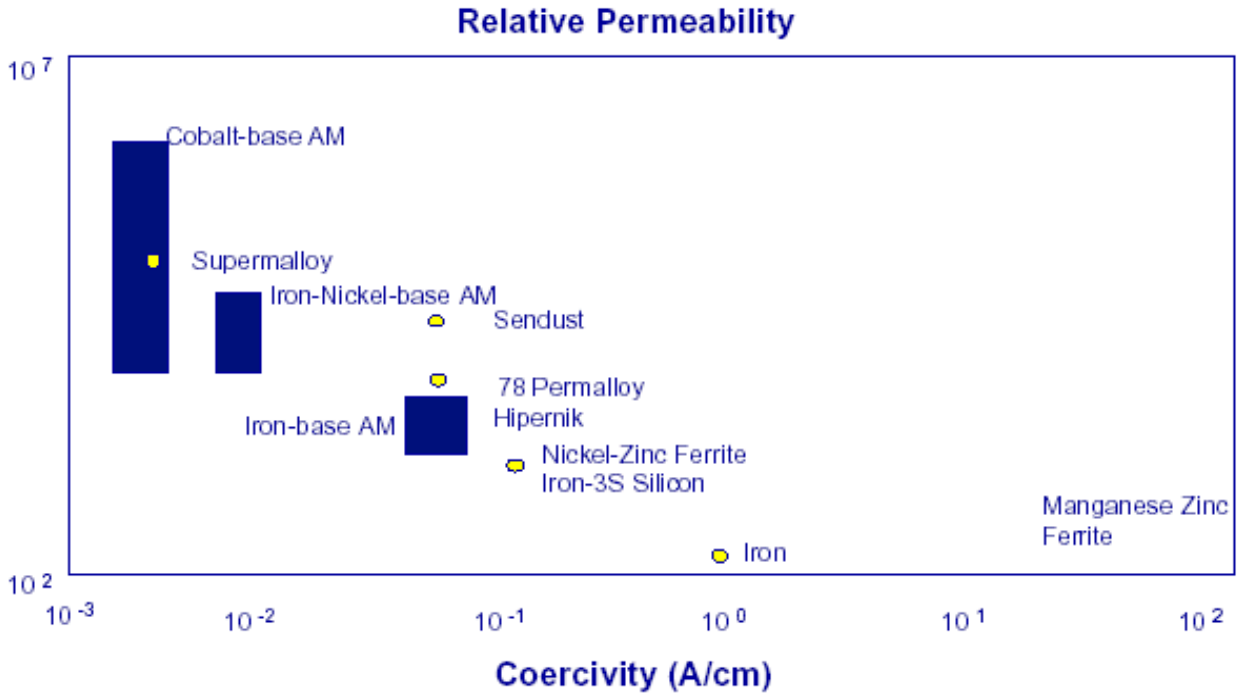
Soft Magnetic Properties
Permeability vs Coercivity



Metglas Alloys are the Superior Choice Based on the Required Optimization

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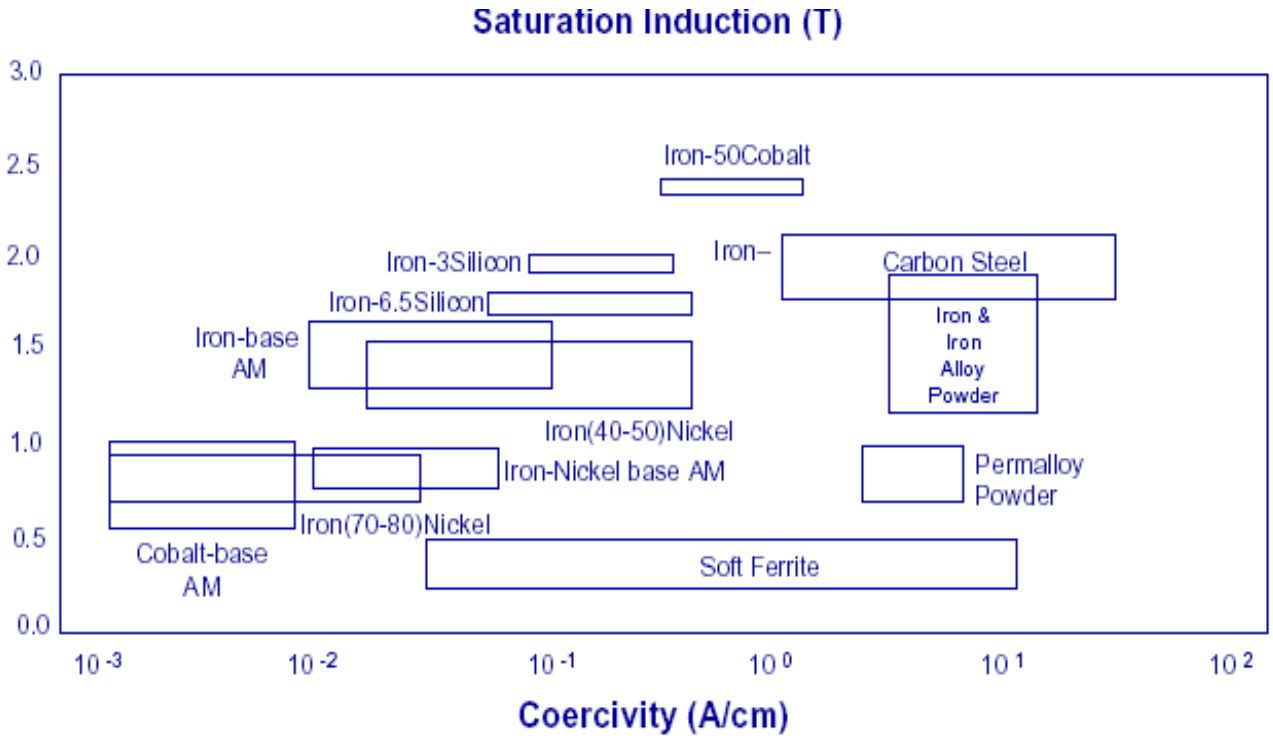
Soft Magnetic Properties
Saturation Induction vs Coercivity



Metglas Alloys are the Superior Choice Based on the Required Optimization

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Magnetic Materials - Performance vs Value

Performance High Low	Low High Value
•Ferrites •Sendust (small) •METGLAS Iron-based (sizes <15 mm) •METGLAS Cobalt-based (sizes <15 mm)	•MPP Ni 80% •High Flux Ni 50% •Sendust Fe 70% •METGLAS Fe 80% •METGLAS Co 75%
•Silicon steel - 14/7 gauge •Iron powder •Some ferrites	•Supermendor •Si Steel (.001, .002, .004") •Ni Steel (80% Permalloy®)

Electronic and Electrical Applications

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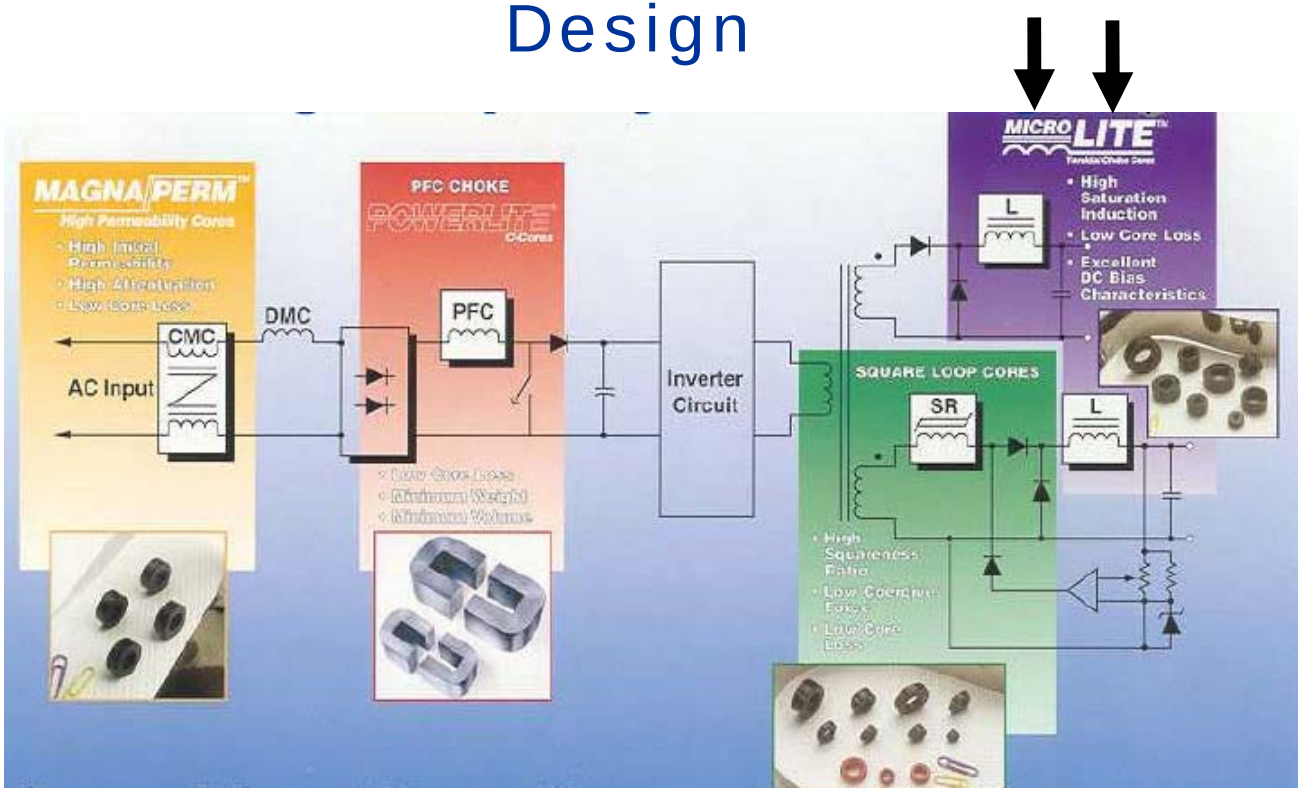
Low Profile Solutions for High Frequency - SMPS Design



Metglas®

Amorphous Metals

Electronic Components

Products

- POWERLITE® ccores (iron based)
- MAGNAPERM ® high permeability cores (cobalt based)
- MICROLITE® choke cores (iron based)
- METGLAS ® square loop cores (cobalt based)

Applications

- Common mode filtering
- Harmonic filtering
- Power factor correction
- Current sensing application

Markets

- Distributed power generation (solar, fuel cell microturbines)
- Telecommunications
- Personal Computers
- Automotive

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MICROLITE® Toroidal Cores

Higher B_{SAT} for smaller component size	è **B_{SAT} 1.56 Tesla**
High permeability (lower I^2R loss)	è **m~250 Less turns**
Extended bias property (%L vs DC bias)	è **Better retention**
Lower magnetic losses	è **85 W/kg @ 100 kHz, 1000 Gauss**
Higher thermal conductivity	**è Ensures good dissipation**
Higher Curie temperature	è **400°C**
Excellent permeability @ high frequency	**è 95% @ 1000 kHz**
High continuous operating temperature	è **150°C (155°C for Class F)**

Iron-Based MICROLITE Cores - Low Energy Losses

MICROLITE® Overview

MICROLITE Applications

- Output Inductor
- Input differential mode inductor
- Flyback transformer
- Power factor correction boost inductor

MICROLITE Manufacturing

- Tape wound toroidal core
- Made from an iron-based amorphous alloy
- Made from patented annealing process of the amorphous alloy

Strengths of Manufacturing Process

- 40 K tons capacity of Conway plant enables small lead-times
- Tape enables manufacture of custom cores without expensive retooling

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MICROLITE® Cores Relative to Other Material Systems

Parameters	MICROLITE	Iron Powder	MPP	Kool Mu	Ferrite
B_{SAT} (T)	1.56	1.0-1.4	.75	1.1	.35
Perm	250	75	125	125	Gap dependent
Power Loss (W/kg)	<80	680	65	140	<65
% Permeability	50	50	50	50	<25
Turns	1	1.8	1.1	1.1	2.1

Assumptions
- *Based on 50% permeability with 50 Oe of bias*
- *2500 perm ferrite was used for comparison*
- *Core loss comparison at 100 kHz and 1 kG BAC*