Nanocomposite Magnet Technology for High Frequency MW Scale Power Converters

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Material Development and Processing

Nanocrystalline Compositions:

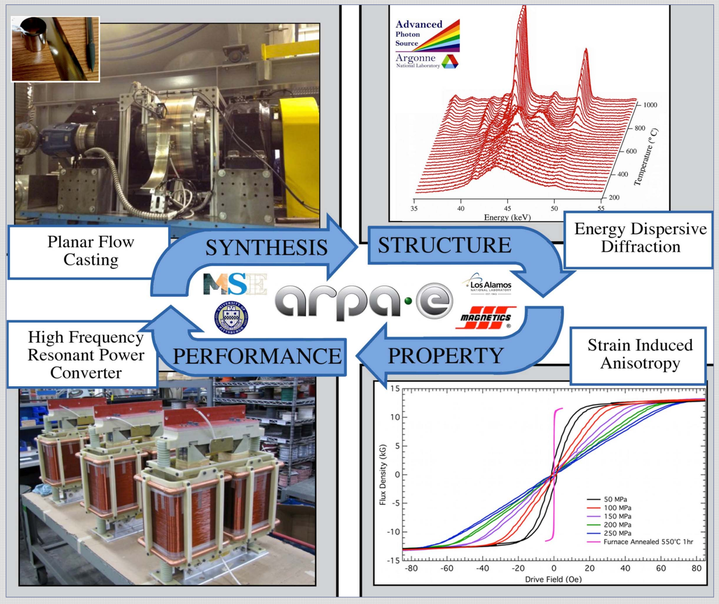
- Amorphous Phase
  - -High Resistivity & Permeability
- Crystalline Particles
  - -Monodomain Sized, ~10nm

Focused Compositions:

-Fe based FINEMET
-FeCo based HITPERM
-Co Rich HITPERM

Targeted Properties:

-High Permeability
-Resistivity>150 μΩcm
-High Anisotropy
-Large Saturation
-Induction



Demonstrating Manufacturability:

Castes produce:
-Amorphous casts
-30-40kg casts
-thickness: ~25μm
-ribbon width: 2''-4''
-edge control

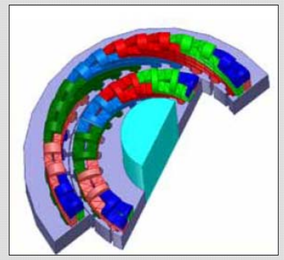
Processing for:
-Thickness Reductions and -Property Control:

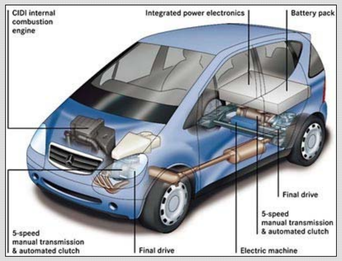
-Strain annealing
-Field annealing
-Rolling

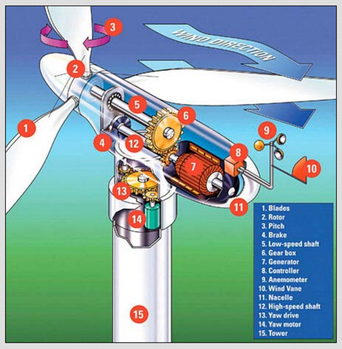
Technology to Market

Proposed Application Testing:

Compare performance of this novel material to state of the art material in present applications.
-Induction Motor Core
-Electric Vehicles
-Permanent Magnet Motor Core
-Wind Turbines
-High Frequency Motors





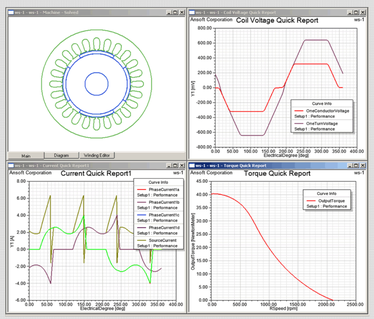


Objective of Testing:

-Novel material promises to increase power density ratio.
-This allows for size reduction in motors for EVs, wind turbines, military and naval applications.
-Test for reductions in Eddie current losses.
-Compare improvements in torque vs. speed curves.
-Generate non-linear equivalent circuits for use in future models.
-Use this data to perform economic analysis and comparison against current technologies.

Method of Testing:

-ANSYS Maxwell 2D, 3D, and RMxprt are employed.
-Inputs: Geometry, Application, Desired Outputs, B-P & B-H curves, Slot Size, Coil Turns, Wire Gage, and other material characteristics
-Apply ANSYS optimization control to analysis.



References:

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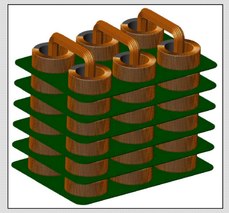
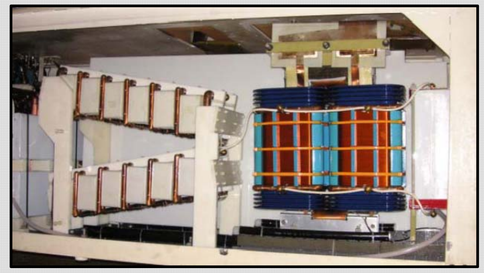
Component Design

Define and Specify Converter Module:

-geometry
-optimal size
-operating conditions
-required material properties
-switches and major components





Resonating Capacitor, nanocrystalline boost transformer, and resonant rectification assembly used in "ILC" L-Band Test Stand. W. Reass

System Modeling:

-analytical
-simulation
-PLEX

System Integration and Economic Analysis

Objective of Study:

Assess the economic impact for energy conversion equipment found within a MW-scale photovoltaic installation operating at higher system frequency.

System Considerations:

The novel transformer core design allows for an overall reduction in cost and size. For *improved* power quality, a multilevel converter topology will interface the transformer. The topology has inherent design redundancy BUT higher device count requiring larger housing and cooling infrastructure compared to a standard, three-phase inverter.

Basis of Evaluation and Comparison:

The economic assessment will consider impacts of components, site preparation, and other related aspects of the system design. Industry information from prior solar installations with the same MW class using a 60Hz transformer will serve as a benchmark.