AML

Reimagining the Magnet Technology that Drives the World

AML Magnets: Thinking Outside the Block!

Advanced Magnetics & Manufacturing

General Presentation for Public Distribution

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Our Company

World-Class Magnet Technologies

AML was founded on principle of developing world-class magnet technologies that solve complex application needs.

- ✓ Significant IP and software portfolio, trade secrets, and knowhow for designing and producing permanent magnets.

Magnet Technologies + Advanced Manufacturing

AML combines its magnet innovation with advanced manufacturing capabilities.

- ✓ AML's team has decades of experience with advanced manufacturing solutions, including leading significant growth transitions.

Funded to Scale – $15M to date

AML has contributed $8.5M along with $1M from strategic sources combined with $5.5M from the U.S. federal government towards commercialization.

- ✓ AML has drawn significant interest from the REE supply chain, private investors, and the federal government to solve the magnet problem.

AML facilities located on Florida's Space Coast Melbourne, Florida

AML expansion plans include additional facilities in Florida and co-location with strategic partners

Recent & On-Going Strategic Engagements

U.S. Department of Energy / ARPA-E ASCEND

- ✓ **2021 – 2025:** Project Title: “High Power Density Dual-Rotor Permanent Magnet Motor with Integrated Cooling and Drive for Aircraft Propulsion.”
- ✓ Patented dual-rotor based on non-sintered PM-Wire™. Specifications provided by large U.S. aerospace and defense company.
- ✓ Program objective – develop magnet and stator technology for lightweight and efficient all-electric powertrain that would help enable net-zero carbon emissions in sing-aisle 150-200 passenger commercial aircraft.

U.S. Department of War / Defense Innovation Unit

- ✓ **2020 – 2022:** Provided funding for the design, build and commissioning of innovative Pilot Manufacturing Process.
- ✓ Program objective – design, build and initial commissioning of an advanced PM-Wire™ Pilot Manufacturing Line for production of non-sintered magnets.

U.S. Defense & Aerospace Company

- ✓ **2020 – Present:** Provided funding for expanded development work with AML’s magnet technology and partnered on application development.
- ✓ Development work led to magnets with “continuously changing magnetization direction” (single-piece Halbach array) using bonded NdFeB material compositions.
- ✓ New collaborations for sintered magnet innovation around AML PM-360 technology for developing and refining manufacturing process.

U.S. Department of War / Defense Logistics Agency

- ✓ **2022 – Present:** Project Title: “Development and Qualification of Domestically Sintered Neodymium Iron Boron (NdFeB) Magnets for Weapons Platforms.”
- ✓ The objective was to qualify sintered PM-Wire™ magnets and to design, build and commission advanced manufacturing for sintered PM-Wire™.
- ✓ Program objective – develop sintered PM-Wire™ magnet configurations using NdFeB compositions – acquisition of equipment and facilities upgrades.
- ✓ Other Collaborations: qualification of sintered magnets for defense and supply chain integration for a domestic supply chain for defense.

U.S. Naval Nuclear Laboratory

- ✓ **2021 - Present:** Designed, commissioned and tested and superconducting / permanent magnet bearing system and other work and projects related to permanent magnets applications and sourcing/qualification.

Our Customer Base

Applications development – We've done 100s of design studies to date

Motor and Generator Applications

AML is working with major motor and generator firms to unlock new performance value and smart supply chain strategies.

Consumer Electronic Applications

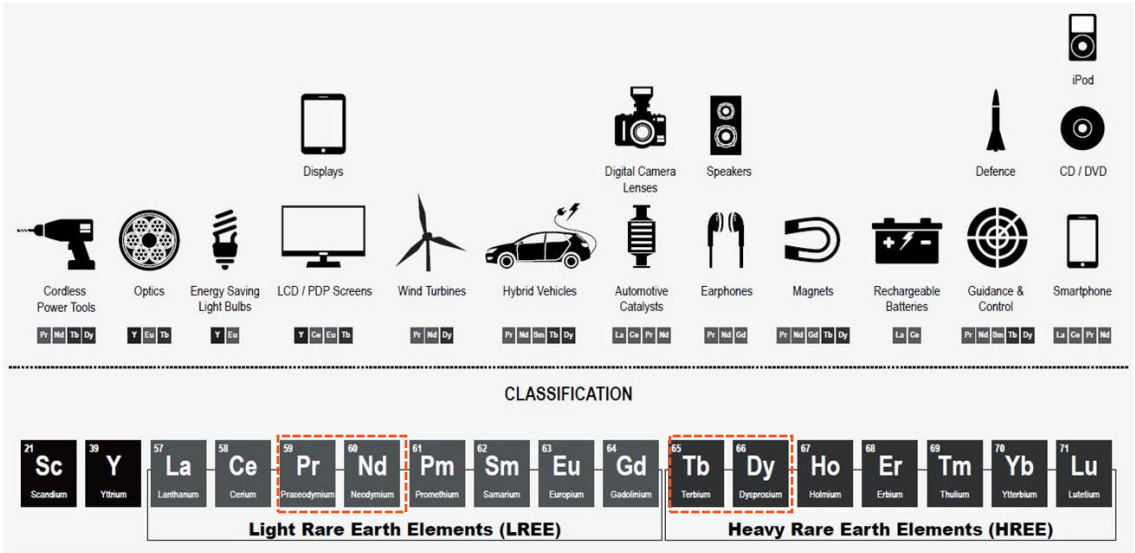
Data storage and other emerging applications are driven by the AI and quantum revolution – need for alternatives is a rapidly growing market.

Defense and Aerospace Applications

AML is engaged with firms developing motor and generator applications for defense.

Other Applications

Medical, robotics, automotive, and others.



Source: China Water Risk report, "Rare Earths: Shades Of Grey – Can China continue to fuel our clean and smart future?" (June 2016)

We are working to remove the constraints of a Neodymium, Praseodymium, Terbium and Dysprosium driven magnet supply chain.

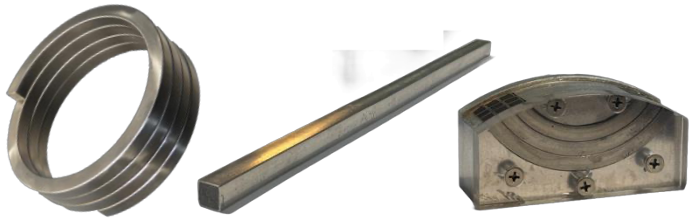
Our Competitive Difference

What separates AML from the rest?

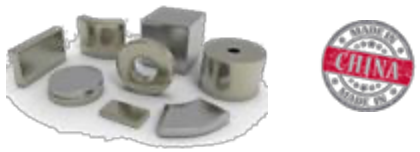
To compete in the United States with global market – you must be able to produce high volume, cost-competitively, and add product value. ***AML can do all three.***

Ideal magnetic distribution, single-piece “Halbach Arrays”, long-lengths with the ability to design in shapes and curvatures that provide applications expanded benefits, including building a magnet around less REE (or non-REE) material attributes.

	AML	Other Magnet Mfg’s
Magnet design	Shapes, sizes, lengths, different magnetizations	Block magnets, magnetized in one direction
Equipment & Capabilities	Automated by design, incorporating standard equipment	Standard equipment for sintered manufacturing with some automation
Manufacturing Processes	High-rate, high yield, automated by design, flexible, and lower capex	Laborious, rigid, non-interchangeable, higher capex
Supply Chain	All magnet materials REE, Non-critical REE, REE-Free	REE - Neodymium Iron Boron REE – Samarium Cobalt



AML PM Magnets



Conventional Sintered Magnets

What Do We Do Differently?

Continuous and controlled process for producing magnets

AML PM-Magnetization™ – Smart design that enables new magnet materials

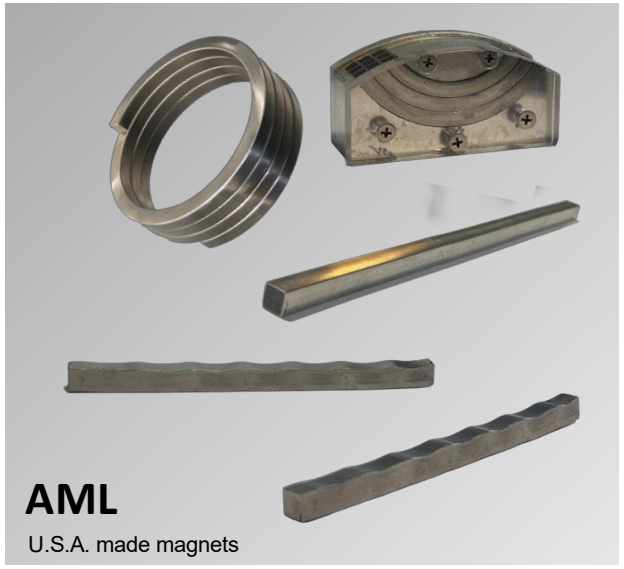
Magnets are sized and magnetized to optimize design and performance of end-use product.

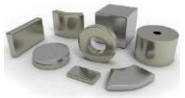
- ✓ World-class, enabling electromagnet and superconducting technology powers AML's ability to create unique magnetization distributions.
- ✓ AML proprietary technology and tooling is specifically designed for rapid magnet design and manufacturing.

PM-Wire™ Manufacturing – Continuous and automated by design

High-yield, high-recyclability, environmentally stable.

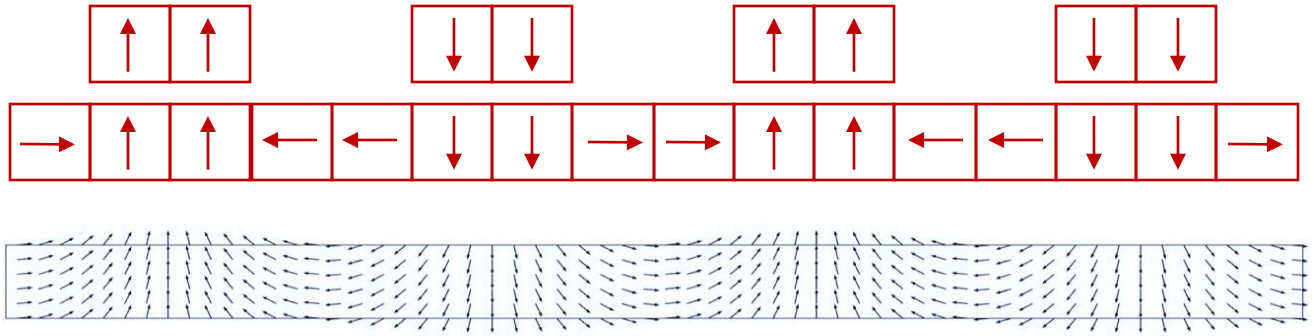
- ✓ Manufacturing process automated and easily modifiable for magnet configurations.
- ✓ Material type does not influence manufacturing setup – only addition of sintering for certain materials.
- ✓ Manufacturing throughput requires less physical footprint than conventional magnet making.





Assembled piece part magnets

AML



North – South Magnetization

Assembled 90 Degree Halbach Array

Single-Piece Magnet, Continuously Changing Flux Direction

Ideal magnetic field distribution, Single-piece "Halbach Array", Long-lengths

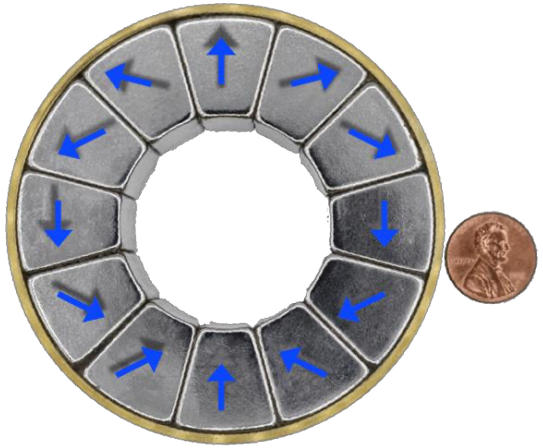
The Industry Today – NdFeB Sintered Block Magnets

Other Magnet Manufacturers

NdFeB are usually produced as uniformly magnetized blocks.

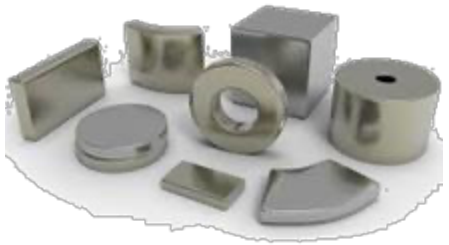
- ✓ Magnets need to be cut from blocks
- ✓ Designers are limited to small magnets with single magnetization directions
  - Design space constraints for the applications
  - Need to combine multiple magnets to achieve variable magnetization directions (expensive tooling)
  - Need high-grade magnets to prevent demagnetization
- ✓ “Single size” fits all approach

Magnet blocks during manufacturing



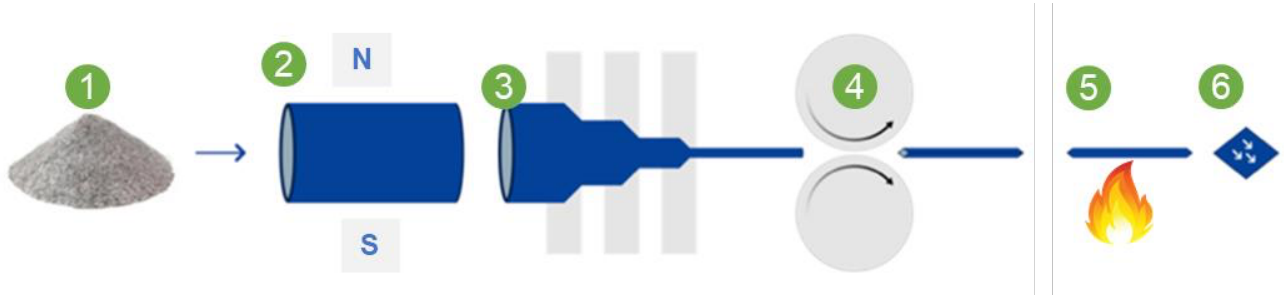
Halbach array composed of uniformly magnetized blocks

Synchronous motor rotor with surface-mounted magnets



COTS magnets

PM-Wire™ Manufacturing Process – Powder-In-Tube Process



(1) Powder is placed in a cylindrical or square tube

(2) Powder is pre-aligned using a magnetic field

(3) Filled tube is sized, leading to compression and cross-section reduction

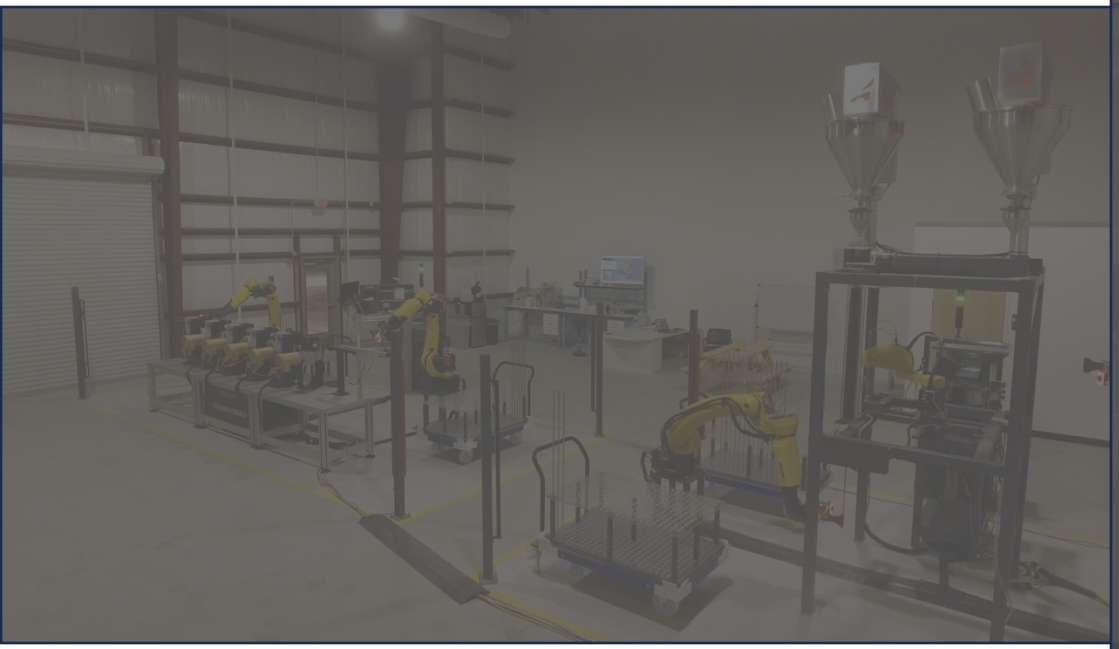
(4) Swaging, rolling to further reduce cross-section, increase density, and obtain the desired shape

(5) Sintering-Annealing-Aging
cutting, grinding, coating

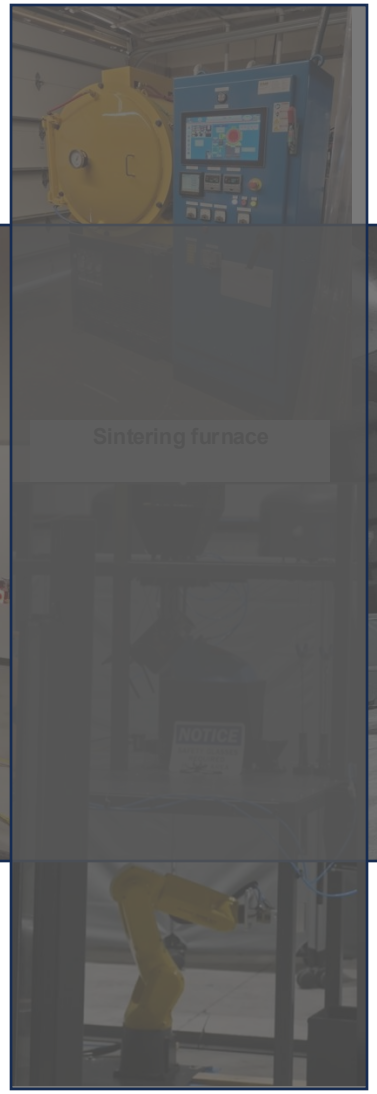
(6) Final magnetization

PM-Wire™ Manufacturing

PM-Wire Magnet Manufacturing



Example of High-Rate Magnets Production Line
Partially funded by U.S. Department of Defense / Defense Innovation Unit



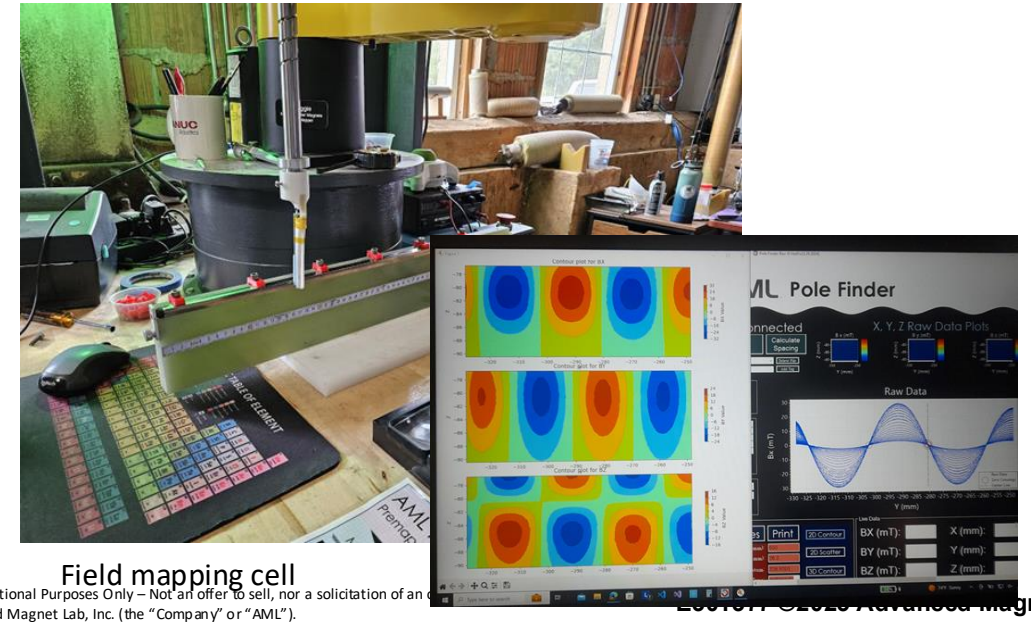
Automated Tube filling in inert environment
Partially funded by U.S. Department of Defense / Defense Logistics Agency

Sintering Facility
Partially funded by U.S. Department of Defense / Defense Logistics Agency

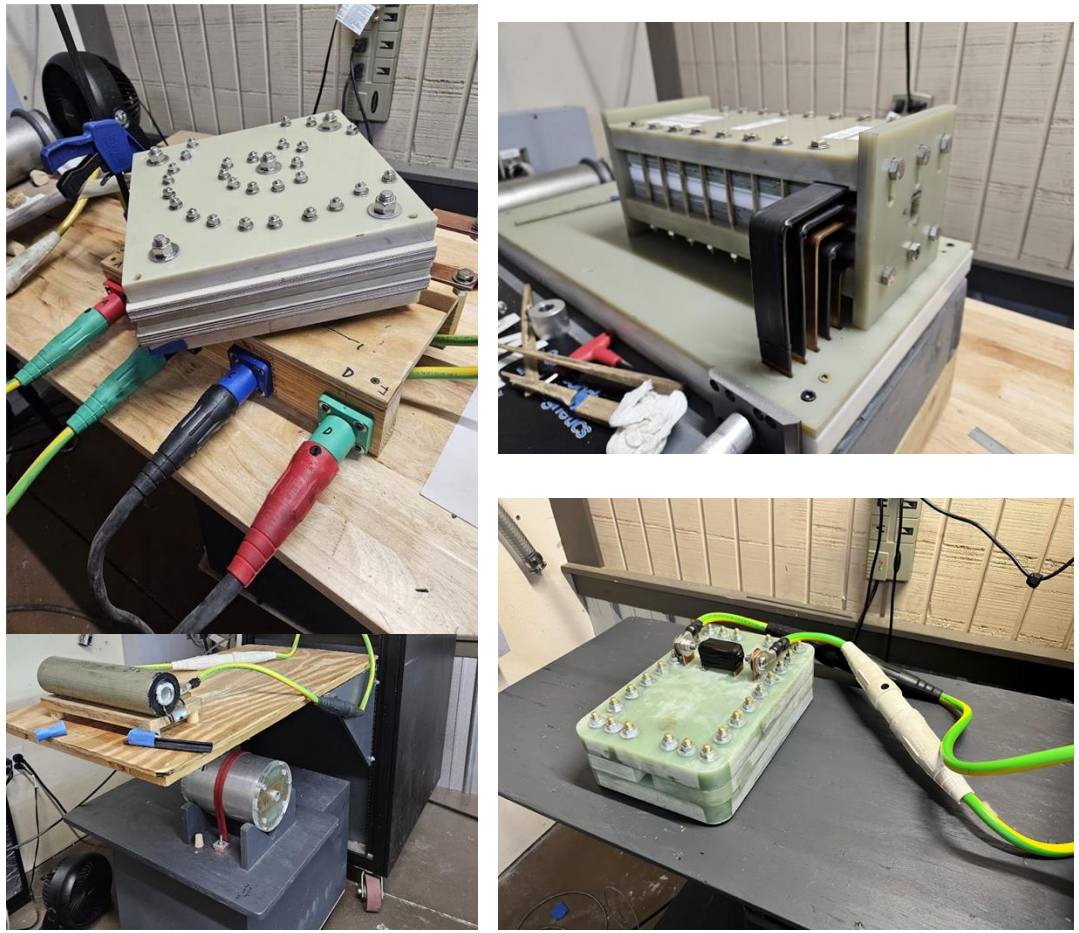
Magnetization

AML has developed custom pre-alignment and magnetization fixtures to achieve useful magnetization configurations

- ✓ Axial for straight and curved magnets
- ✓ Radial for rings and curved magnets
- ✓ Uniform for long straight magnets and large blocks
- ✓ PM-360 (single piece multipole)
  - Radial inward and outward flux
  - Axial flux



Field mapping cell



Example of custom magnetization fixtures

PM-Wire™ Process for Sintered Magnets

Only 1 step requires an inert environment

Flexible shapes

- ✓ Long straight magnets
- ✓ Curved magnets

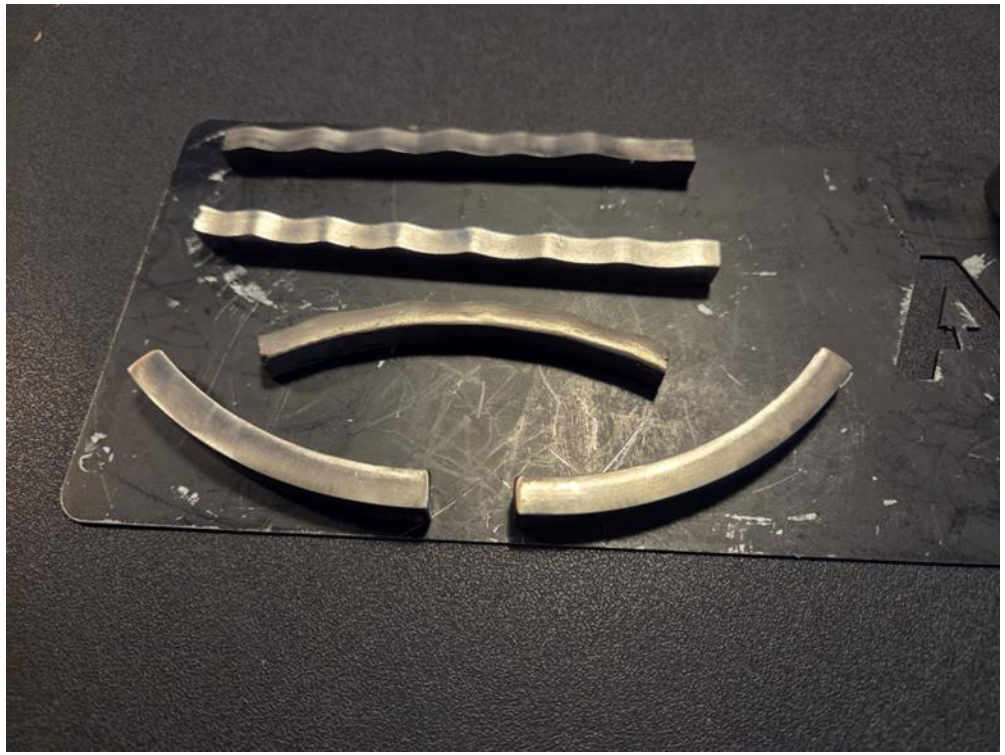
Flexible magnetization directions

- ✓ Radial
- ✓ Axial
- ✓ Continuously changing (**PM-360™**)

Opens the design space for applications

- ✓ Applications no longer constrained to small uniformly magnetized block magnets

6-pole single-piece NdFeB magnet (PM-360™)

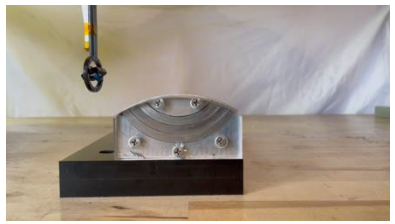


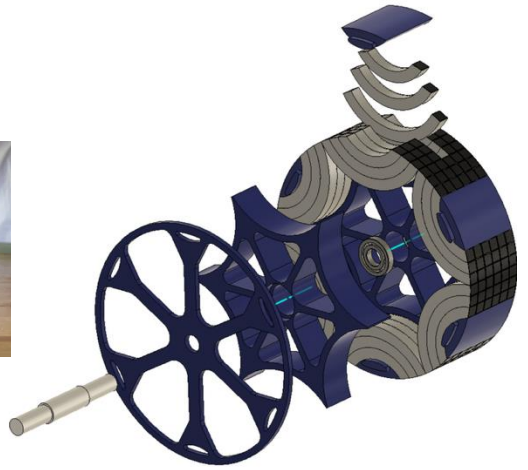
Examples of axially magnetized wound magnets (PM-Axial™) and multipole magnets PM-360™)

Why PM-Wire Magnets Matter?

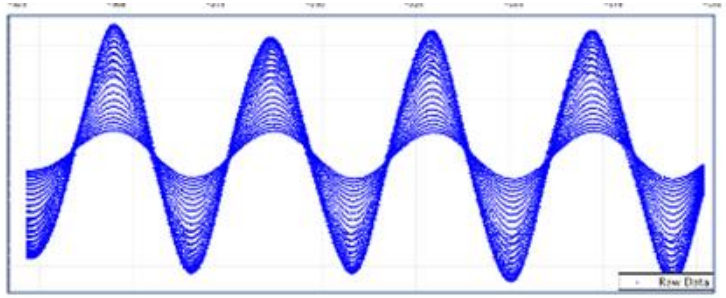
Flexibility in magnet shape and magnetization direction opens the design space for the applications and smart design:

- ✓ Minimize demagnetization
  - Allows operation at higher temperatures
  - Enables the use of lower coercivity magnets (**less REEs, nor Heavy REEs**)
  - Enables new designs and topologies
- ✓ Generate multiple poles from single magnets
  - Significantly reduce the number of parts/magnets
  - Simplify assembly: no tooling needed
  - Enhance the field magnitude
  - Produce sinusoidal fields (no space harmonics)
  - Enable the use of lower Br magnets

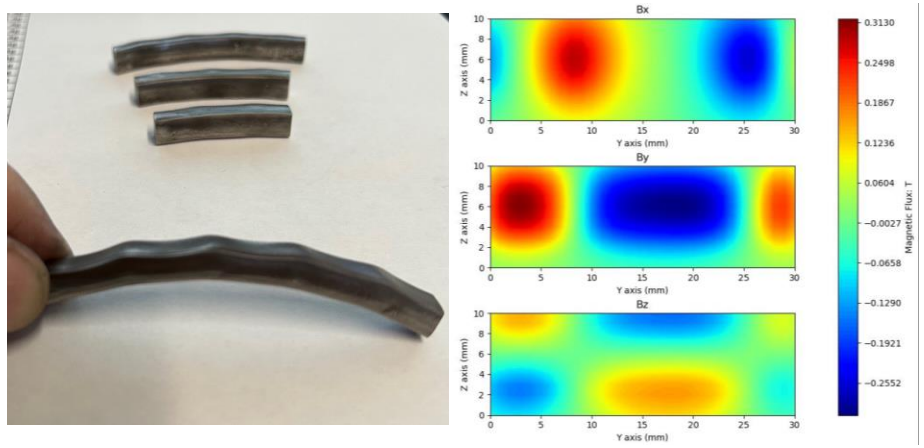




PM-Axial rotor configuration: demagnetization field < 0.15 T in the rotor magnets!



Magnetic field measurements of the field produced by a PM-360™ magnet



Example of curved sintered PM-360™ magnets

Example of Use of PM-Axial™ Magnets – Global Electrical Machine Manufacturer AML

Baseline Design

Torque - 311 Nm; Efficiency - 98.6%; Power - 375 kW; RPM - 11,500

Magnet Material: N48SH NdFeB

Maximum Operating Temperature: 100 C

Critical REEs: NdPr and Dysprosium

PM-AXIAL™ Impact – Significant Improvement In Performance

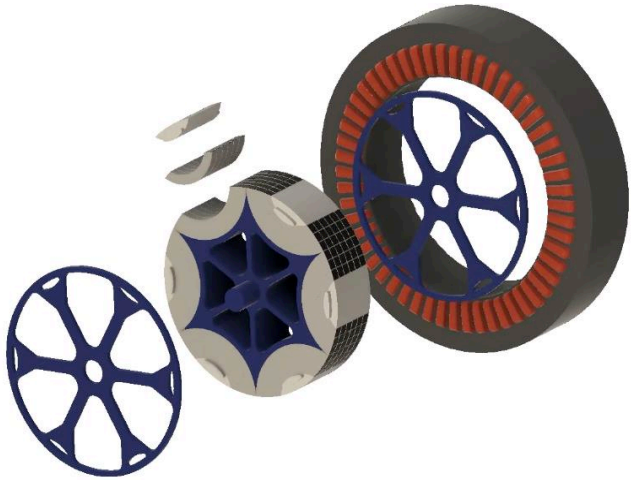
Solution

- ✓ Retrofit solution replaced conventional surface-mounted magnets topology with PM-AXIAL™
- ✓ No change to stator
- ✓ Same magnet N48SH NdFeB alloy

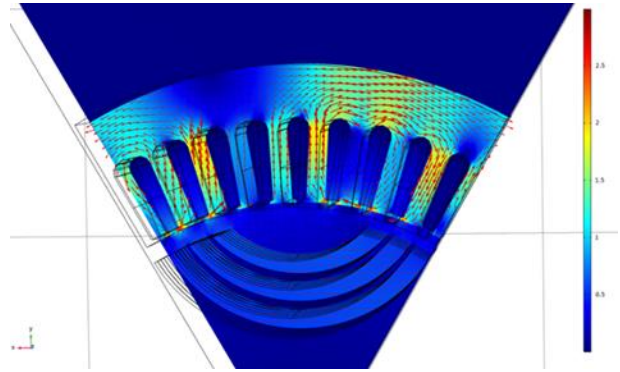
PM-Axial™ Performance Improvement

- ✓ Field enhancement
- ✓ Increase in operating temperature to over 150 C
- ✓ Reduction in rotor overwrap thickness
- ✓ 20% reduction in mass by removing the iron

Baseline Design – Conventional north-south pole rotor configuration



PM-AXIAL™ - Provides very-low demagnetization field (~ 1/10 of conventional north-south pole configuration)



Magnetic field distribution in 1 pole of the motor

Example of Use of PM-Axial™ Magnets – Global Electrical Machine Manufacturer AML

PM-AXIAL™ Impact – Reduced Critical REE

Solution

- ✓ Retrofit solution replaced north-south rotor pole topology with PM-AXIAL™
- ✓ No change to the stator
- ✓ **(Mischmetal / NdPr) NdFeB** alloy
  - Br and Hci (@ 120 C) = 1.01 T and 2.85 kGauss

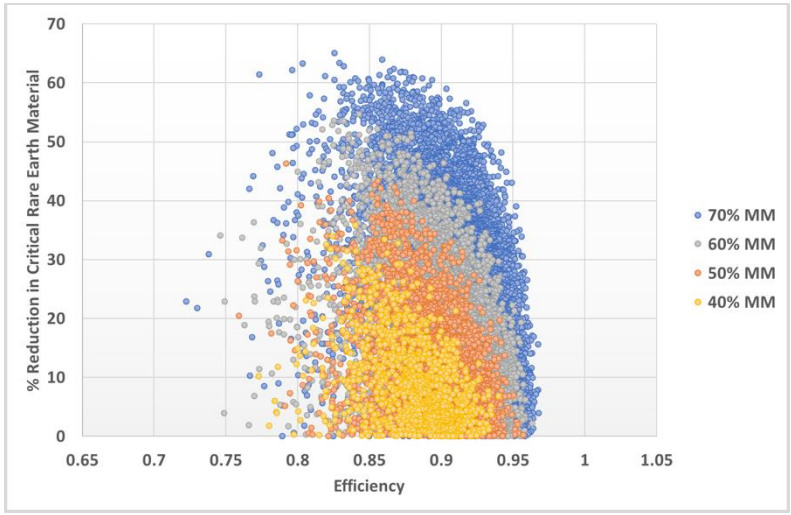
PM-Axial™ Performance

- ✓ Equivalent torque and efficiency
- ✓ 37% reduction in critical REE (**NdPr**) and **no dysprosium**
- ✓ 11% reduction in active mass

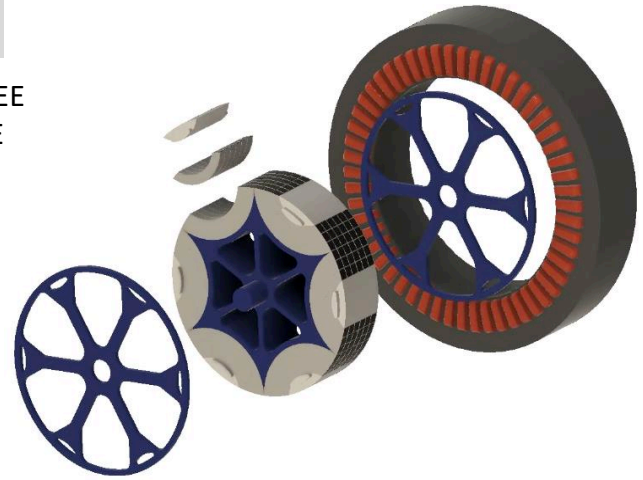
NdPr - ~ + $80 per kilogram

Mischmetal - $lower per kg
(Cerium, Lanthanum, Neodymium, Praseodymium)

Mischmetal reduces the cost of REE separation and can provides REE provenance of NdPr oxides



Example of Reduction in critical REE materials vs. efficiency



PM-AXIAL™ - Provides very-low demagnetization field (~ 1/10 of conventional north-south pole configuration)

AML's Other Sintered Magnets

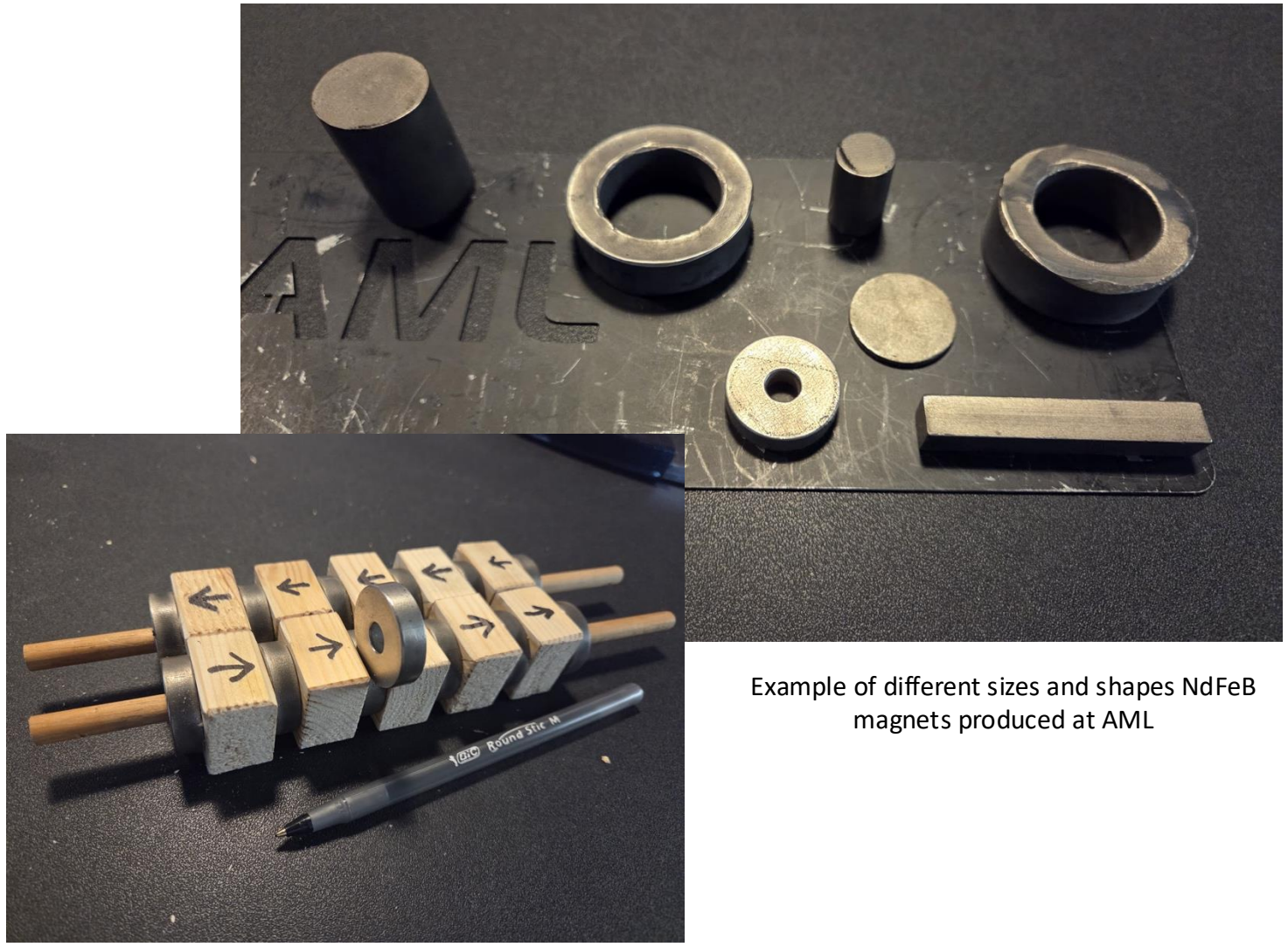
Conventional magnet shapes

- ✓ Blocks, cylinders, "donuts", rings

Uniform magnetization

- ✓ Radial
- ✓ Axial
- ✓ Transverse

Produced in long lengths close to final cross-section or close to final shape



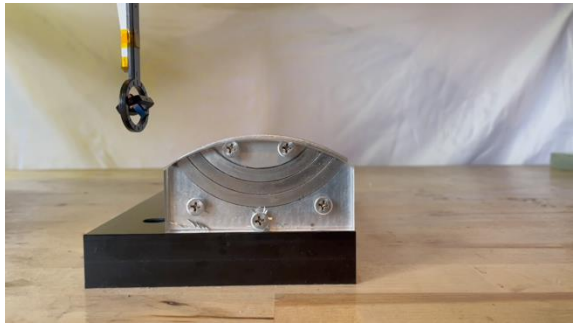
Example of different sizes and shapes NdFeB magnets produced at AML

Example of NdFeB magnets produced at AML

PM-Wire™ - A Material Enabler

Materials

- ✓ SmFeN
- ✓ NdFeB
- ✓ MnBi
- ✓ MnAlC
- ✓ FeN
- ✓ Other



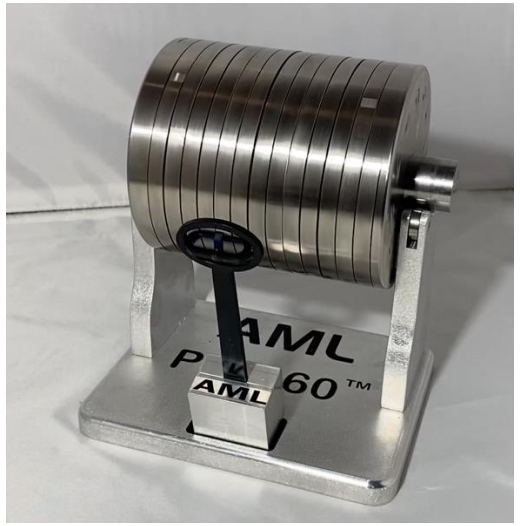
PM-AXIAL™ Magnets

PM-UNIFORM™ Magnets

PM-360™ Magnets

Engineering magnets

- ✓ Custom shapes
- ✓ Custom magnetization direction
- ✓ Strong: strength of Stainless steel
- ✓ No cracking, no chipping
- ✓ No corrosion (magnets sealed in jacket)



PM-360™ Radial Flux Rotor

PM-360™ Outrunner Rotor

PM-360™ Axial Magnetization

Example of PM-360™ Applications in Motors

Motor Specifications

Collaboration with the Oak Ridge National Laboratory

U.S. Department of Energy: Power - 58 kW; RPM - 20,000

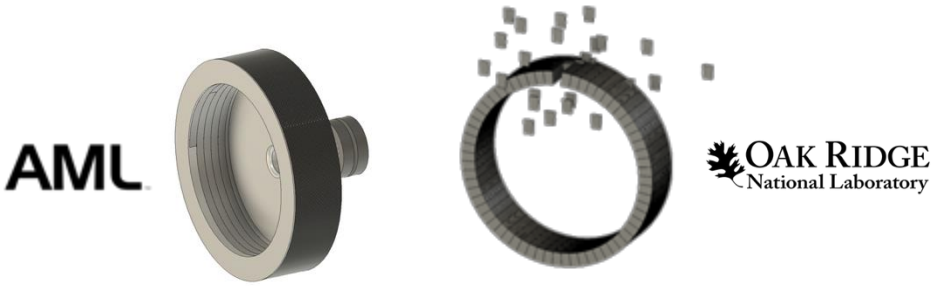
PM-360™ Impact – EV Motor With Non-Sintered Alloy

Solution

- ✓ Retrofit solution replacing Halbach rotor topology with PM-360™
- ✓ Replacing **~2,750** NdFeB thin sintered magnets with **8 PM-360™ rings**
- ✓ **SmFeN**
  - Br and Hci (@ 80 C) = 0.9 T and 14 kOe

PM-360™ Performance

- ✓ Equivalent torque and efficiency
- ✓ Significantly reduce part count and complexity of assembly
- ✓ Lower eddy current losses
- ✓ A fraction of the cost compared to sintered complex Halbach array design



PM-360™ Halbach Array

PM-360™ Impact – Enable the use of SmFeN

Torque - 311 Nm; Efficiency - 98.6%; Power - 375 kW; RPM - 11,500

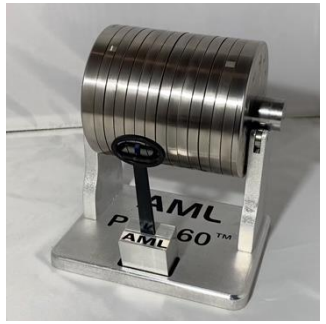
Maximum Operating Temperature: 100 C

Solution

- ✓ Retrofit solution replaced north-south rotor pole topology with PM-360™
- ✓ No change to motor stator
- ✓ **No Critical REE - Samarium Iron Nitride (SmFeN)** alloy
  - Br and Hci (@120C) = 0.88T and 11.5 kGauss @120C
- ✓ Replace 168 sintered N48SH magnets with **10 PM-360™ rings**

PM-360™ Performance

- ✓ Equivalent torque and efficiency
- ✓ 10% reduction in active mass
- ✓ No NdPr or Dy



PM-360™ - Helical

PM-360™ - Ten (10) Helical Rings replacing 168 sintered magnets

Qualification of “Non-Sintered” PM-360™

PM-360™ - “Single-piece Halbach Array”

Straight, ring or helical magnets with “Continuously Changing Magnetization Direction”

Materials

NdFeB – NeoMagnequench, Aichi Metals
SmFeN – Sumitomo Metal Mining, Nichia
MnBi – AML and domestic suppliers

Lower Cost Assemblies

Reduced part count
Easy to assemble

Stability

Tube filled in an inert environment: the powder is sealed in tubes before compaction: → No Corrosion
Mechanical strength of Stainless Steel
Magnets can deform without cracking or breaking
Magnets cannot chip
PM-Wire process ideal for mass production

Example of PM-360™ Magnet assembly for axial flux motor.

PM-360™ Motor during testing

What is the magnet supply chain?

What are Permanent Magnets?

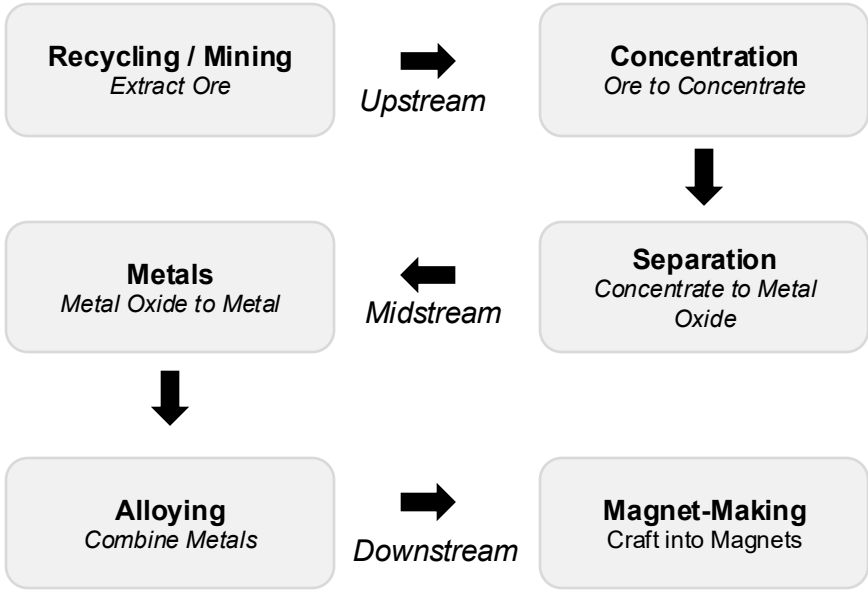
Permanent magnets are made from hard ferromagnetic materials such alloys of iron, cobalt, and nickel, or from ceramic materials such as iron oxide.

Neodymium	Neodymium iron boron (NdFeB) magnets are used in motors, generators, sensors, and applications such as power tools, MRI machines, power generation, and military uses.
Ferrite	Ferrite magnet applications include electric motors, speakers, and consumer products like refrigerator magnets.
Samarium Cobalt	Samarium Cobalt (SmCo) magnets are used in high temperature applications such as motors, actuators, and applications that require heat resistance.
Alnico and other	Motors, generators, sensors, and other component applications.

Quick Market Facts

- NdFeB and ferrite magnets account for over 90% of the global production of permanent magnets in the world.
- Heat and temperature can permanently weaken magnets – alloy compositions and magnet design can reduce this.
- Global permanent magnet market is expected to **exceed $40B by 2030**.
- Electric motors present one of the largest market opportunities for permanent magnets.

Steps in the Supply Chain



Each step may be represented by a single company or integrated together depending on the business and supply chain case.

What are we producing?

AML's Magnets – Outside the Block

AML's permanent magnets are made with the application in mind – shape, magnetization, material choice, and more.

	Description	AML Value Proposition	Target Applications
NdFeB	• Neodymium iron boron (NdFeB) sintered magnets. • AML seeks to reduce dysprosium (Dy) and terbium (Tb) where possible with magnet design.	• Flexible shapes (long straight, curved). • Flexible magnetization (radial, axial). • Single-piece Halbach (PM-360™).	• High power density permanent magnet motors. • Industrial motors.
(Mischmetal-Nd)FeB	• Sintered permanent magnets with lower content of Neodymium and no heavy rare earths. • AML replaces Nd, when needed with Lanthanum (La) or Cerium (Ce).	• Less critical rare earth elements. • No heavy rare earth content. • Increased traceability with inputs for customers.	• Permanent magnet motors with less critical REEs. • High power density permanent magnet motors.
SmFeN	• Samarium Iron Nitride (SmFeN) non-sintered magnets. • SmFeN is traditionally used in injected molded or bonded magnet making.	• Flexible shapes (long straight, curved). • Flexible magnetization (radial, axial). • Single-piece Halbach (PM-360™).	• Permanent magnet motors. • IPMs. • Industrial motors.
MnBi	• Manganese Bismuth (MnBi) was developed in the 1950s by the U.S. Naval Laboratory. • MnBi is highly corrosive, AML eliminates this issue with PM-Wire and does even more with the material than any other magnet making method.	• Rare earth free (domestic supply). • High coercivity at high temperature. • No corrosion. • High mechanical strength.	• Permanent magnet synchronous reluctance motors. • IPMs.
In Development	• AML is continuing to develop magnets with materials previously underserved by commercial markets. • **Examples include:** PM-360™ Samarium Cobalt, hybrid neodymium alloy compositions, other non-rare earth magnets.	• See above and prior slides.	• Defense applications. • High end permanent magnet motors.

AML's Market – Permanent Magnets

A Perspective into Our World

Global Magnet Market Size – 2030

Magnet Type	$ Billion	CAGR
Neodymium (NdFeB)	$29.3	9.00%
Ferrite	$12.3	7.00%
Samarium Cobalt (SmCo)	$0.7	2.50%
Alnico	$0.4	7.00%
Other	$0.3	5.00%
Total	**$43.0**	

NdFeB Magnet Market by Application

Application	Share
Offshore wind turbines	27%
Electric vehicles	28%
Consumer electronics	20%
Industrial motors	16%
Non-drivetrain motors	7%
Other sintered magnets	3%
Total	**100%**

Example Base Case – AML Potential TAM

By Business Segment	$ Billion
SmFeN displacement of NdFeB	$1.5
MnBi displacement of Ferrite	$0.7
Sintered NdFeB	$0.3
Total	**$2.5**

AML is transforming supply chains and unlocking value for customers and stakeholders.

The Math Behind the Logic:

AML Market Capture	
SmFeN displacement of NdFeB	10.00%
MnBi displacement of Ferrite	10.00%
Sintered NdFeB	0.95%

Total Addressable Market (TAM) – is the largest possible market size, assuming no constraints like competition, geography, capital scarcity, or regulation.

NdFeB Total, $ Billion	**$29.3**
NdFeB in Motor	$14.7
% in Motor	50%
% SmFeN Adoption	10%
Ferrite Total, $ Billion	**$12.3**
Ferrite in Motor	$7.1
% in Motor	58%
% MnBi Adoption	10%

Estimate Notes

- Conservative growth and market size comparable to data from industry and publicly available reports.
- Total Addressable Market is a function of target market for electric motors and potential adoption of AML technology and displacement of existing markets. AML believes that these estimates are conservative and with further analysis could be larger.
- No assumption for significant adoption of AML enabling sintered 'block magnet market' with PM-Wire.

How do we get our supply?

AML has spent nearly a decade building supply chain relationships with the biggest and the best around the world.

	Collaborations and Partnerships
NdFeB	• ReElement Technologies (oxides and metals). • Rare Element Resources (oxides). • Phoenix Tailings (metals).
Samarium Iron Nitride (SmFeN)	• Several global firms for sourcing SmFeN with strategic partnerships planned for supply and collaborative sourcing of Samarium. • AML is qualifying PM-Wire and PM-360 permanent magnets with SmFeN for motor, generator, and other customer applications.
Manganese Bismuth (MnBi)	• Several sources and strategic partnerships planned for supply and collaborative sourcing of Manganese and Bismuth (non-Rare Earth). • Powder production at AML pending further business developments with domestic suppliers.

*American Resources Corporation, a 19% stakeholder of ReElement Technologies, is a stakeholder of AML with board representation.

AML is building alliances across the magnet supply chain and unlocking new benefits for suppliers.

Our Supply Chain

AML is spearheading several supply chains driven by customer demand.

	NdFeB	(Mischmetal-Nd)FeB	SmFeN	MnBi
Magnet Material	Neodymium, Iron, Boron	Mischmetal (Mixture of Cerium, Lanthanum, Neodymium), Iron , Boron	Samarium Iron Nitride	Manganese Bismuth
Commercialization Customers	Existing NdFeB magnet market users	In development	Motor and generator companies	Motor and generator companies
Key Ingredients (1)	Neodymium (30%) Iron (68%) Boron (1%) Other (Pr, Dy, Tb)	Neodymium (15 - 22%) Iron (68%) Boron (1.5%) Other (Mischmetal)	Samarium (23%) Iron (73%) Nitrogen (3%) Other (1%)	Manganese (50%) Bismuth (50%)
Other Comments	New sources coming online an available increasingly in coming years.	Replacing Nd with Mischmetal presents significant cost savings and traceability for applicable applications.	AML has strategic partnerships developing for SmFeN and sourcing and separating Samarium ex-China.	Domestic sourcing, refining, and processing of these materials is underway in the United States.

(1) Ratios are estimates based upon public information and subject to change or be of varying opinions or preference. NdFeB generally includes dysprosium and/or terbium for performance requirements.

AML invites new opportunities for strategic relationships for sourcing oxides, metals, and alloys.

Our Plans

AML "Warp Speed Expansion"

Existing Footprint

10,000 square feet – Alloys and Magnets < 1,000 MTPY

- ✓ Low-rate production, advanced applications prototyping, materials & magnet R&D.
- ✓ Strategic sourcing with suppliers of REOs, metals, alloys, and magnet materials.

Stage II and Stage III

50,000 + square feet – Metals, Alloys, and Magnets - Commercial MTPY

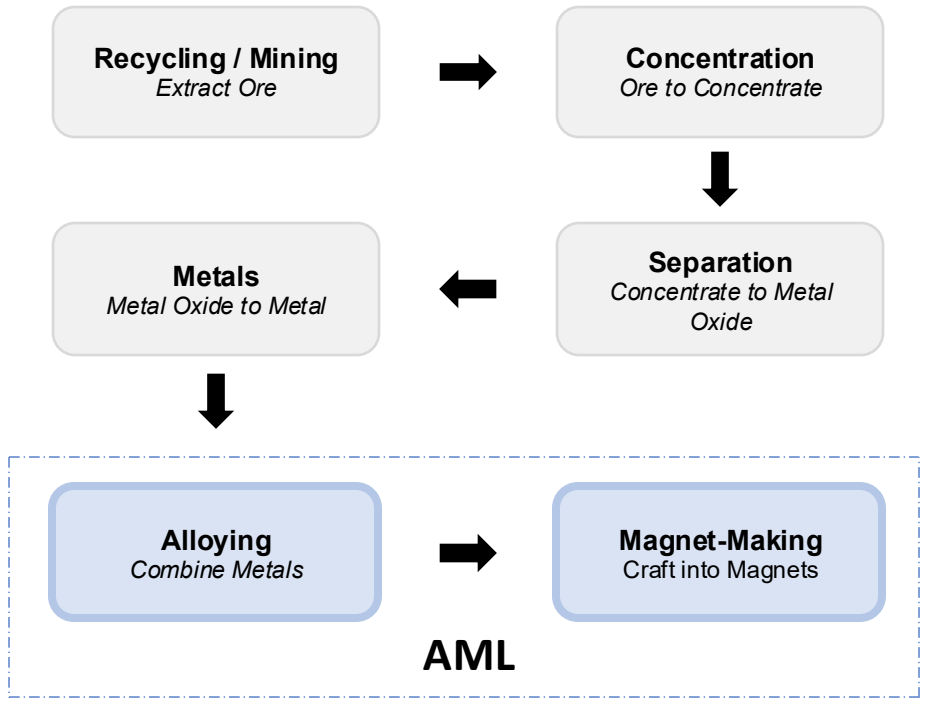
- ✓ Stage II: Scaled magnet manufacturing.
- ✓ Stage III: Expansion with metals, alloys, magnet materials collaborations + partnerships production for supporting magnet making.
- ✓ AML executes exclusive / strategic partnerships with REO suppliers and magnet material producers.

Stage IV – AML 10x

Multiple Sites – Co-Location with Suppliers and Customers

- ✓ Global expansion with AML PM-Wire™ manufacturing partnerships with strategic customers and suppliers.
- ✓ AML will be fully integrating material development and scaled in-house compositions for novel magnet materials that expand beyond NdFeB.

"Source to Magnet Supply Chain"



AML intends to expand capabilities organically to scale magnet making globally.

Let's Partner

AML - The Future of Magnetics

REE supply partnerships

Let's build a diversified globally supply chain for value-add magnet products

Let's build better products with magnets

Innovation for improved applications through smart magnet designs

Enabling new magnet materials for a tech revolution

AML is leading the transition to non-REEs and new materials for applications

AML-Enabled.com

Corporate Address

Advanced Magnet Lab, Inc.
1604 S Harbor City Blvd.
Melbourne, FL 32901
media@amlsm.com

Management

Wade Senti, President
wsenti@amlsm.com
321.501.6660

Philippe Masson, CTO
pmasson@amlsm.com
321.728.7543

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