

US Magnet Materials Association

**The US Magnet
Materials Story
Past-Present-Future**

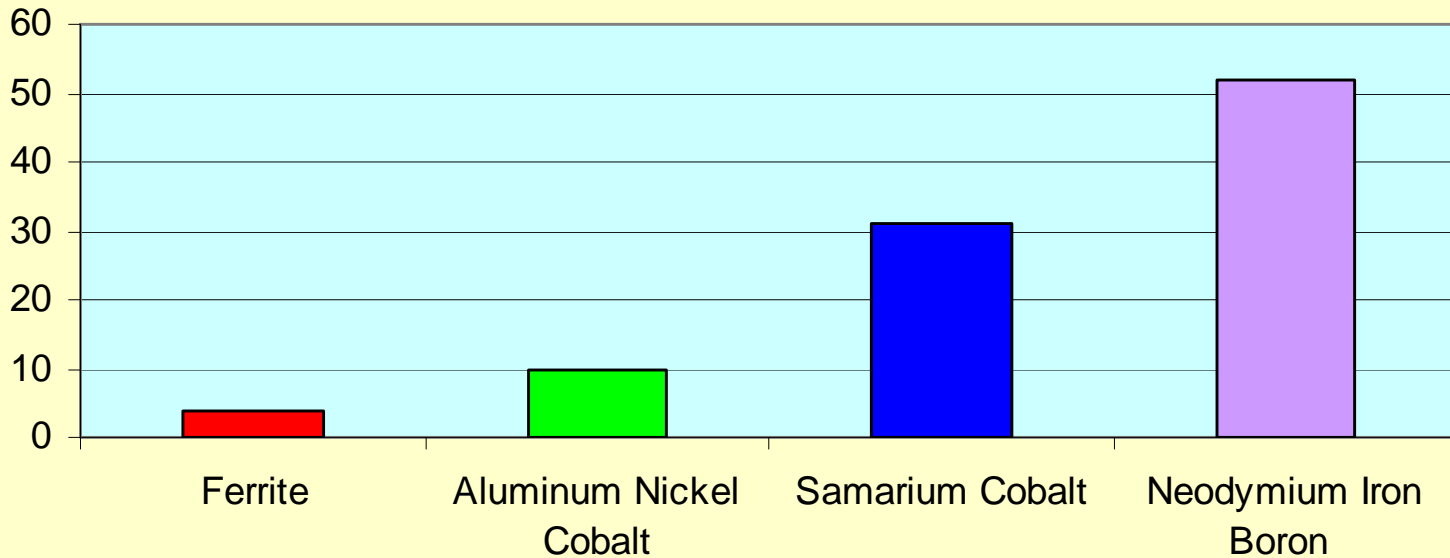


What do Magnets do?

- Move and direct Electrons
- Provide Magnetizing & Mechanical forces
- Electromagnets - need electrical current
 - Coil & “soft magnetic materials”
 - Normal copper & superconductor
- Permanent Magnets – no electrical current
 - “Hard magnetic materials”

Permanent Magnet Types & Strength

Varying Magnetic Strengths (MGO)



↖ ↗
Rare earths

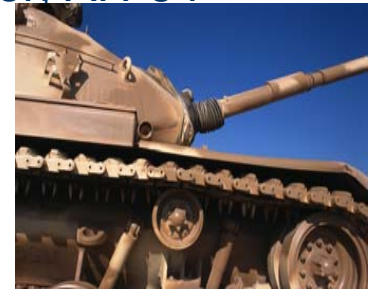
DOD Applications

- Inertial Guidance
- Electronic Warfare
- Microwave Communications (ship-shore, ground-space, space-ground)
- Motors (hydraulic systems, motion control)
- Generators (power for aircraft, ships)
- Space (actuators, electric propulsion)
- Nuclear reactors (pumps, control rod actuators)

DOD Platforms



- Missiles
 - Trident, Minuteman IV, Patriot, PAC III, Tomahawk Cruise Missiles, JDAM's, Hellfire missiles, Harpoon Anti-ship
- Navy
 - Aegis radar, Virginia Submarines, CVN, DDX, LCS, UUV's, support "all electric ship" technologies, Firefinder RADAR
- Army
 - M1A1 tanks, Bradley A3 and FIST, Paladin Howitzer, AH-64 Apache, Striker Humvee
- Air Force
 - F-15, F-16, F-18, B-52, Joint Strike Fighter
 - Unmanned Aerial Vehicles



China Dominates Magnet Materials

WW Total Market Size \$7.5B
(2006) Projected \$11B 2010

Japan, US, European
producers close
plants, move
production

NdFeB magnets
75% (22%
Japan)

Over 1/2 WW Alnico
& SmCo
production

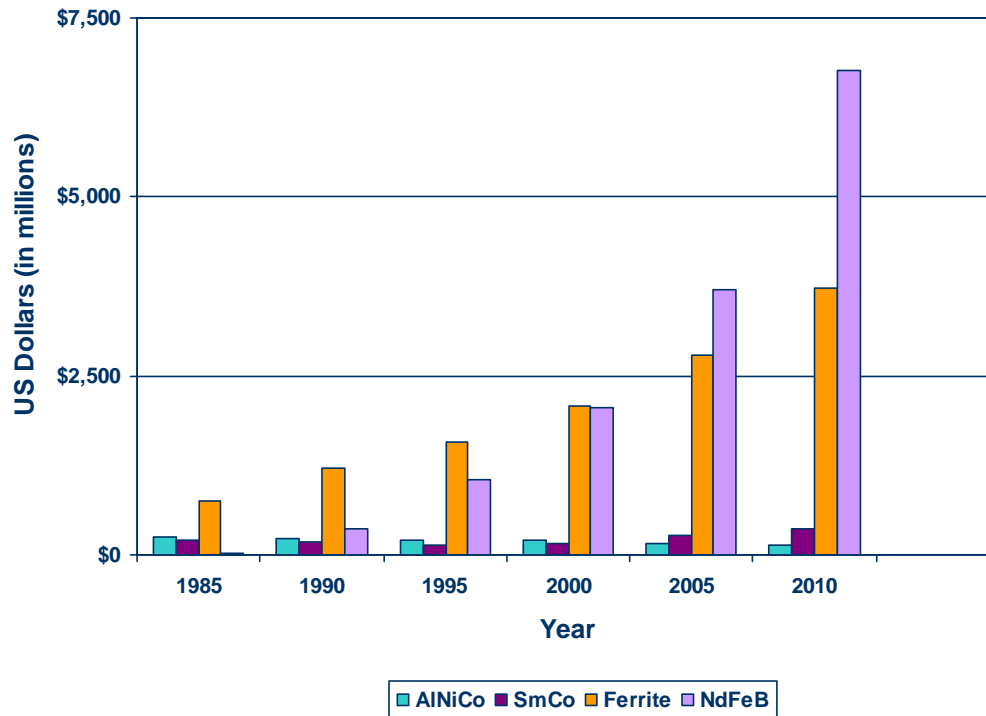
Rare Earth Oxide
Ore production
94% (50% WW
reserves)

Rare Earth pure
Metals nearly 100%

Hard ferrites 85+ %



Magnet Sales Worldwide

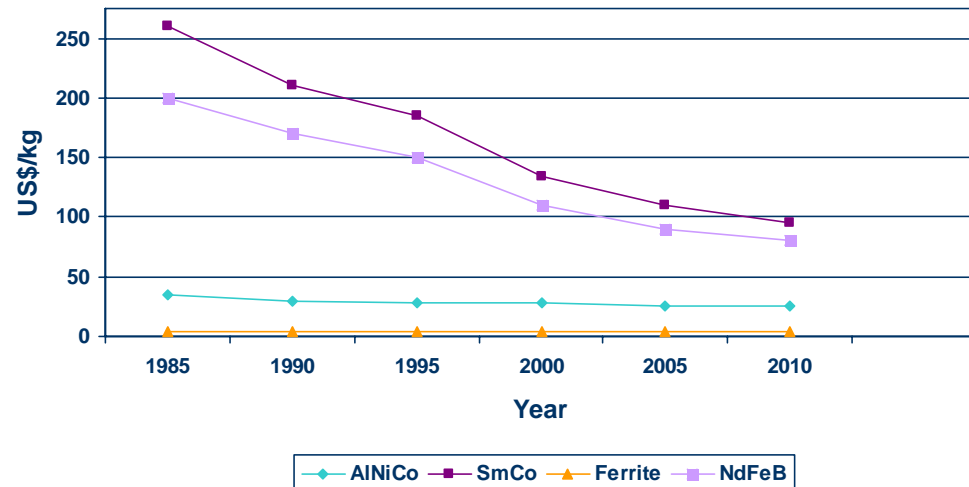


- Market is growing due to automotive & more uses, miniaturization
- Chinese are main beneficiaries of growth
- China will increase share & dominance

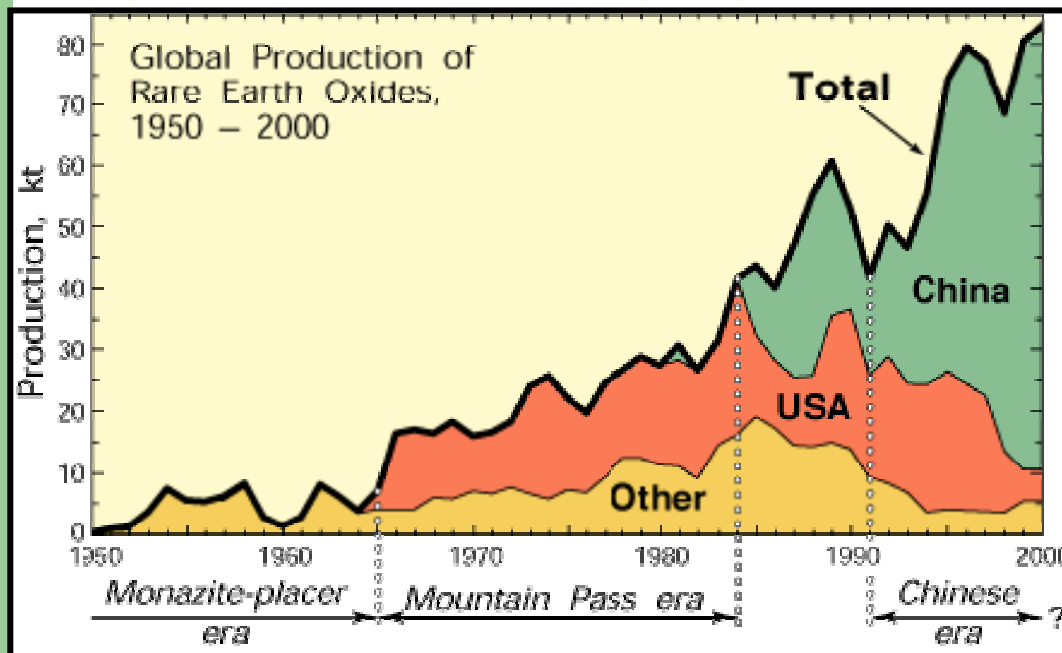
Data courtesy of
Webmagnetics.com

Magnet Prices \$/kg Worldwide

- China deflates price
- Artificial Chinese pricing makes US un-competitive
- Export subsidies provided
- Over capacity within China
- Critical Loss of Knowledge base
- Gross Chinese Patent Infringement



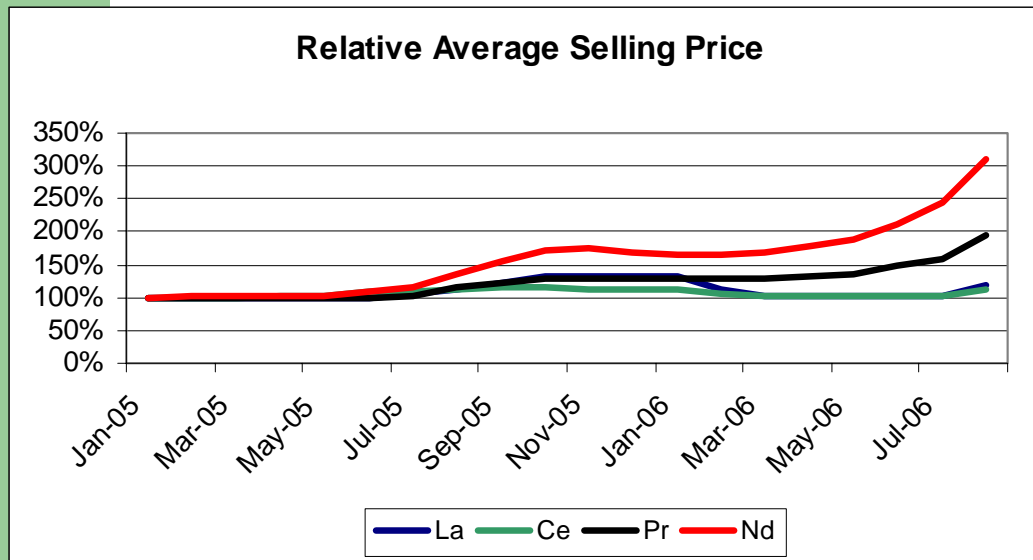
WW Rare Earth Oxide Production



- 1965-1985 US major production
- 1985-1990 China enters
- 1990-2000 China mines dominate
- 2002 Last US mine closes

Source: US Geological Survey

China Rare Earth Metals Price Manipulation



- China overcapacity drives out all other producers
- Government sets export caps & price minimums
- China established \$100/ton fine for violations to price minimums (14 July 2005)
- High risk for other producers to invest on added capacity
- Inability to purchase Nd metals reported
- Rare earth metal buybacks from customers mandated at sub market level
- China views downstream user implications of price increases having positive effects
- Neodymium metal Price History
 - 1989 \$42/kg
 - 2003 \$8/kg
 - 2006 \$28/kg
 - 2007 \$52/kg
 - 2008 \$40/kg

Sources: metal-pages.com, China Rare Earth Information Center

Recent Decline of US Magnet Industry

- **2002 Mountain Pass, CA rare earth mine suspends operations**
 - world's richest rare earth reserves
 - only one in US
- **2003 Magnequench closes plant and moves equipment to China**
 - former GM subsidiary
- **2003 VAC closes Elizabethtown, KY operations**
- **2004 China National Offshore Oil Corp attempts to purchase Unocal**
 - owner of Molycorp and Mountain Pass rare earth mine
- **2005 Hitachi closes its Edmore, MI production facility**
 - acquired from GE in 1990's

Who survives in US Magnet Industry?

Remaining US magnetic material producers:

- 3 Alnico magnet producers
- 1 Samarium Cobalt magnet producer
- 0 Neodymium Iron Boron magnet producers
- 2 Grain Oriented Electrical Steel (GOES) producers
- 0 Rare earth oxides or rare earth metals production
- 2 non-captive Ferrite producers

***If domestic magnet industry disappears,
China will become a critical US defense supplier.***

Who survives in US Magnet Production?

Remaining US permanent magnet producers:

Alnico Magnets

- Thomas & Skinner
 - Indianapolis, IN
 - 170 employees
- Permanent Magnet Corporation
 - Indianapolis, IN
 - 50 employees
- Arnold Magnetic Technologies
 - Marengo, IL
 - 140 employees

Samarium Cobalt

- Electron Energy Corporation,
 - Landisville, PA
 - 100 employees

Hard Ferrites

- Hoosier Magnetics, Inc. (ferrite powder)
 - Ogdensburg, NY
 - 50 employees

If domestic magnet industry disappears, who will develop unique materials for mission specific DOD needs AND commercialize?

Strategic Materials Provision Applicability to Permanent Magnet Materials

Hard (Permanent) Magnets

- Three general types:

- Alnico
- Rare Earth
 - SmCo
 - NdFeB
- Hard Ferrites

Soft Magnetic Materials

- Multiple types, including:

- Powdered iron

- Electrical steel

- Soft Ferrites

Materials covered by
10 U.S.C. 2533b



USMMA SUMMARY

- US Magnet Materials Industry **IS NOT DEAD**
- 10 U.S.C. 2553b Applies to US magnet Industry
- Permanent Magnets are critical to Military Hardware and weapons systems
- US Defense needs domestic advanced, specialized magnet technology capabilities for unique mission needs

“There is oil in the Middle East. There are rare earths in China. We must take full advantage of this resource.”

Deng Xiaoping, 1992



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