Optimum Corrosion Protection of Nd-Fe-B Magnets

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Sponetaneous Materials

Nd-Fe-B Magnets

Optimum Corrosion Protection of
We go about our daily lives understanding almost nothing of the world.

Carl Sagan
from the Introduction to “A Brief History of Time” by Stephen W. Hawking
Outline

• History
• Prevention
• Testing
• Conclusions
History

- The first incorrect assumption
- First attempts to correct/the second incorrect assumption
- Corrosion mechanism
- Coatings
- The second iteration
The First Incorrect Assumption

• Because of their many similarities, most of what we know about SmCo magnets will apply to Nd-Fe-B magnets

• Therefore coating may not be necessary
The Second Incorrect Assumption
Corrosion Mechanism

- Diffusion of $\text{O}_2$, $\text{H}_2\text{O}$ or $\text{H}_2$
- Primarily along grain boundaries
- Acid treatments prior to coating: a source of $\text{H}_2$
Common Coatings

• Al-Chromate
• Epoxy Resin Spray
• Electrodeposition
• Ni Plating
The Second Iteration

Control the microstructure

• Reduce or eliminate excess Nd
• Control O$_2$
• Add Co, Ga, Nb, Mo and V
Keys to Preventing Corrosion

A combined approach

• Controlling the chemistry of the grain boundary phase
• Preparing the surface for coating
• Applying the coating correctly
Verification
Verification Methods

• HAST
  – Highly Accelerated Stress Test
• Temperature and humidity
• Salt spray
HAST Equipment

- Temperature
- Humidity
- Pressure

Espec Corporation
Conclusions

If you make magnets
• Control composition
• Coat with care
• Verify the coating

If you use magnets
• Choose your magnet supplier & coater carefully
• Verify, verify, verify