

Optimum Corrosion Protection of Nd-Fe-B Magnets

S. R. Trout

Spontaneous Materials

Magnetics 2004

Denver, CO

June 10, 2004



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

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



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

Outline

- History
- Prevention
- Testing
- Conclusions



History

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



Magnetics 2004
Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

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



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infoweb.com/conferences.htm>

Spontaneous Materials

The Second Incorrect Assumption



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

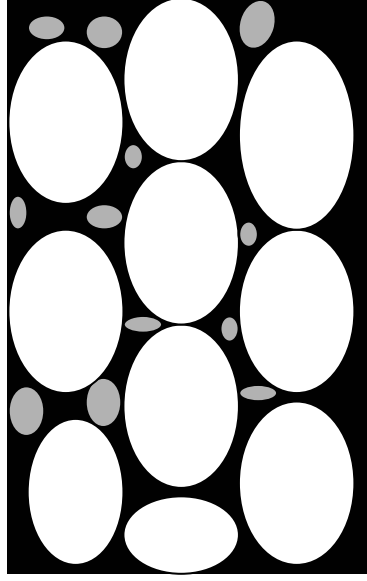
Spontaneous Materials



Magnetics 2004
Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

Corrosion Mechanism



- Diffusion of O_2 , H_2O or H_2
- Primarily along grain boundaries
- Acid treatments prior to coating: a source of H_2



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

Common Coatings

- Al-Chromate
- Epoxy Resin Spray
- Electrodeposition
- Ni Plating



The Second Iteration

Control the microstructure

- Reduce or eliminate excess Nd
- Control O₂
- Add Co, Ga, Nb, Mo and V



Magnetics 2004
Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infoweb.com/conferences.htm>

Spontaneous Materials

Keys to Preventing Corrosion

A combined approach

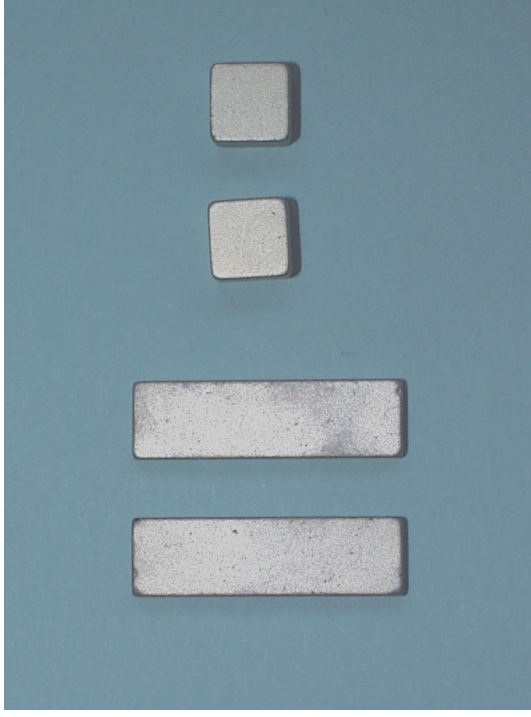
- Controlling the chemistry of the grain boundary phase
- Preparing the surface for coating
- Applying the coating correctly



Magnetics 2004
Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

Verification



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

Verification Methods

- HAST
 - Highly Accelerated Stress Test
- Temperature and humidity
- Salt spray



HAST Equipment



- Temperature
- Humidity
- Pressure

Espec Corporation



Magnetics 2004

Advancements in Magnetic Applications, Technology & Materials
June 9-10, 2004 - Denver Marriott Tech Center - Denver, CO
<http://www.infowebcom.com/conferences.htm>

Spontaneous Materials

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