CURTISS WRIGHT Flow Control Company

New Neutron Absorbers

Industry Meeting with NRC
Neutron Absorber Material Degradation

October 4 2012

BENSHAW CWFC Korea EES Engineering & Services EMD ENERTECH EST Group Farris Engineering Farris Engineering Services NETCO
NOVA QualTech NP SCIENTECH Solent & Pratt Sprague Products SWANtech Target Rock TAS VSC

Neutron Absorbers in US Spent Fuel Pools

Supplier	Product Name	Matrix	Absorber
BISCO*	Boraflex	Poly Dimethyl Siloxane	Boron
Ceradyne/AAR*	Boral	Al 1100 Alloy	Boron
Holtec/Metamic LLC*	Metamic	Al 6061 Alloy	Boron
BÖHLER Bleche	Neutronit	304 Stainless	Boron
Carpenter	NeutroSorb	ASTM A887	Boron
Carborundum Co.*	Caborundum	Phenolic Resin	Boron
ESK*	Tetrabor	Phenolic Resin	Boron
Alcan	W1100N.XXB	Al 6351 Alloy	Boron

*Former Supplier/Out of Business

Change in Absorber Market

- Available neutron absorbers for spent fuel pool are almost exclusively Aluminum and Stainless Steel based materials
- No polymer or resin based neutron absorber material currently being marketed for spent fuel pool use
- Stainless Steel based materials use boron and/or gadolinia as the neutron absorber
- Aluminum based materials use boron as the neutron absorber

Neutron Absorbers Available for SF Pools

Stainless Steel Based Materials

Supplier	Product Name	Matrix	Absorber
Carpenter	???????	Stainless Steel	Boron, Gadolinia
BÖHLER Bleche	Neutronit	Stainless Steel	Boron
Carpenter	NeutroSorb	Stainless Steel	Boron
ATI Nuclear Energy	NUSHIELD	Stainless Steel	Boron

Neutron Absorbers Available for SF Pools

Aluminum Based Materials

Supplier	Product Name	Matrix	Absorber
Ceradyne	BORAL	Al 1100 Alloy	Boron
Ceradyne	BORTEC	Al 1100, 6090 Alloy	Boron
Holtec	Metamic	Al 6061 Alloy	Boron
Aluminum Core Technology	MAXUS	1070 Al core 5052 Al Alloy clad	Boron
Talon Composites	Talbor	Al 6061 Alloy	Boron
Alcan	W1100N.XXB	Al 6351 Alloy	Boron

Neutron Absorbing Fe-Base Alloy

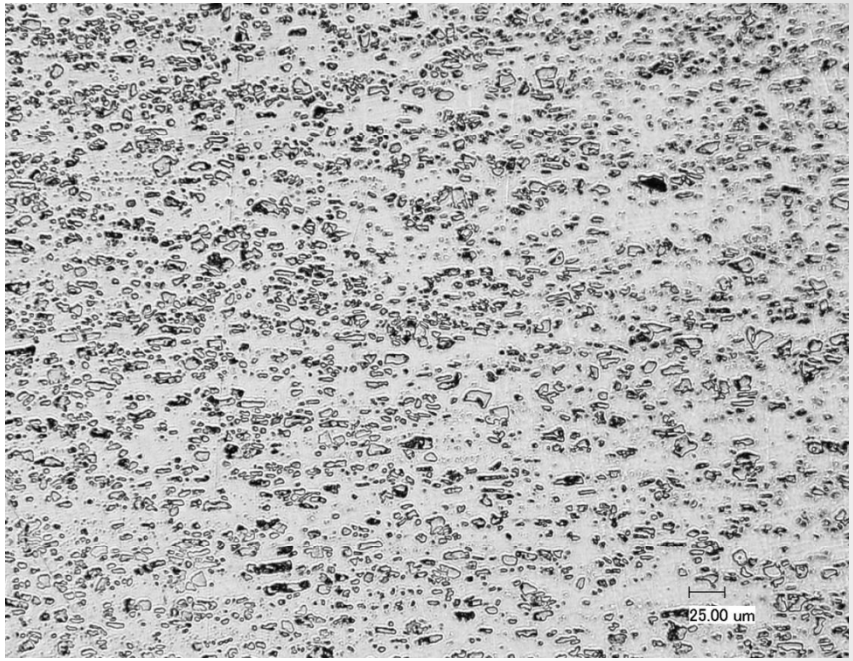
Boron, Gadolinia Stainless Steel

- Carpenter Technology Corporation
- Wyomissing, PA
- www.cartech.com/ssalloysprod
  - No data on this product
- Austenitic powder metallurgy
- At least 0.25 wt.% boron
- At least 0.05 wt.% gadolinia
- Available as sheet or plate
- Product is in development

Neutronit®

Borated Stainless Steel

- BÖHLER Bleche GmbH & Co KG
- Mürzzuschlag, AUSTRIA
- www.bohler-bleche.com/english/special_alloys
- ASTM-A887 Alloy
- Boron content up to 1.9 wt.%
- Available as plate, sheet or strip
- In service at Ginna
- Corrosion performance testing data – Ref. 1

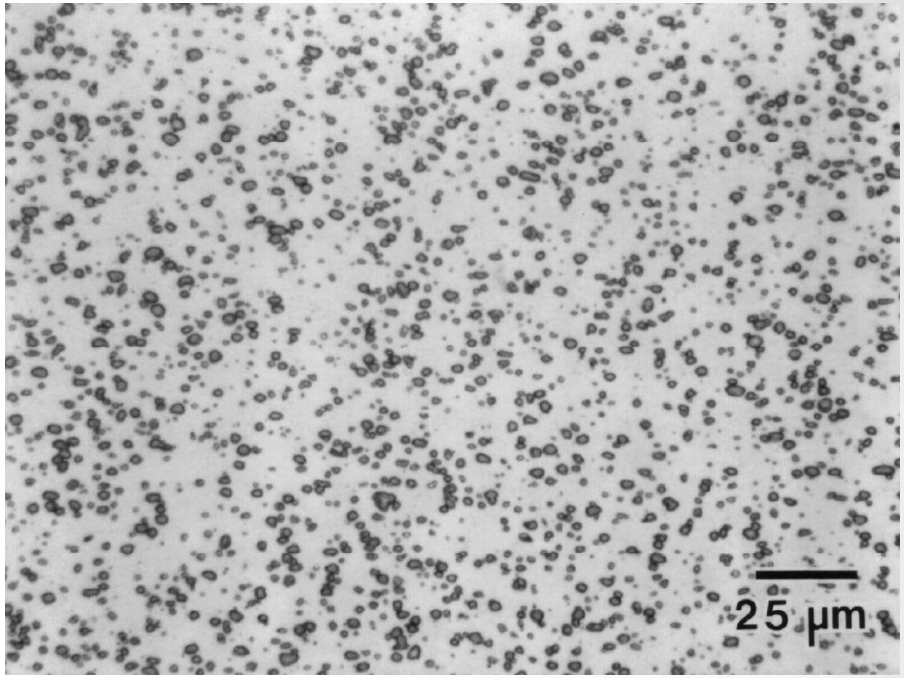


Neutronit A 978 w/1% Boron

NeutroSorb PLUS®

Borated Stainless Steel

- Carpenter Technology Corporation
- Wyomissing, PA
- www.cartech.com/ssalloysprod
- ASTM A887-89 Grade A Alloy
- Boron content up to 2.5 wt.%
- Available as sheet or plate
- In use at the US MOX facility
- In use in US commercial reactor spent fuel pools
- Corrosion performance testing data – Ref. 1

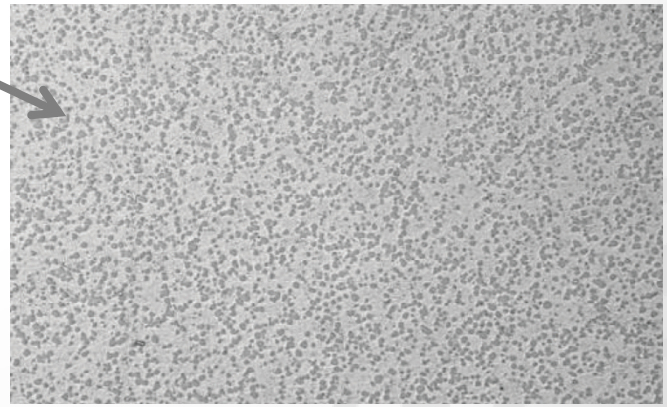


NeutroSorb Plus 1.17 wt.% boron

NUSHIELD™

Borated Stainless Steel

- Allegheny Technologies Incorporated
- Pittsburgh, PA
- www.ATImetals.com
- 304 Stainless Steel Matrix
- Boron content 1.75-2.25 w/o
  - Finely dispersed chrome-borides
- Available as sheet or plate
- In use at the US MOX facility
- Not in service in US commercial reactor spent fuel pools
- Corrosion performance testing data – Ref. 2



BORAL®

Aluminum Boron Carbide Cermet

- Ceradyne, Inc.
- Quebec, Canada
- www.ceradyneboron.com/products
- 1100 Aluminum Alloy Clad
- Aluminum, Boron Carbide Core
- B_4C content up to 67 vol.% in the core
- Available as sheet
- Not in service in US commercial reactor spent fuel pools
- Corrosion performance testing data – Ref. 3
  - EPRI Long Term Corrosion Performance Test

BORTEC®

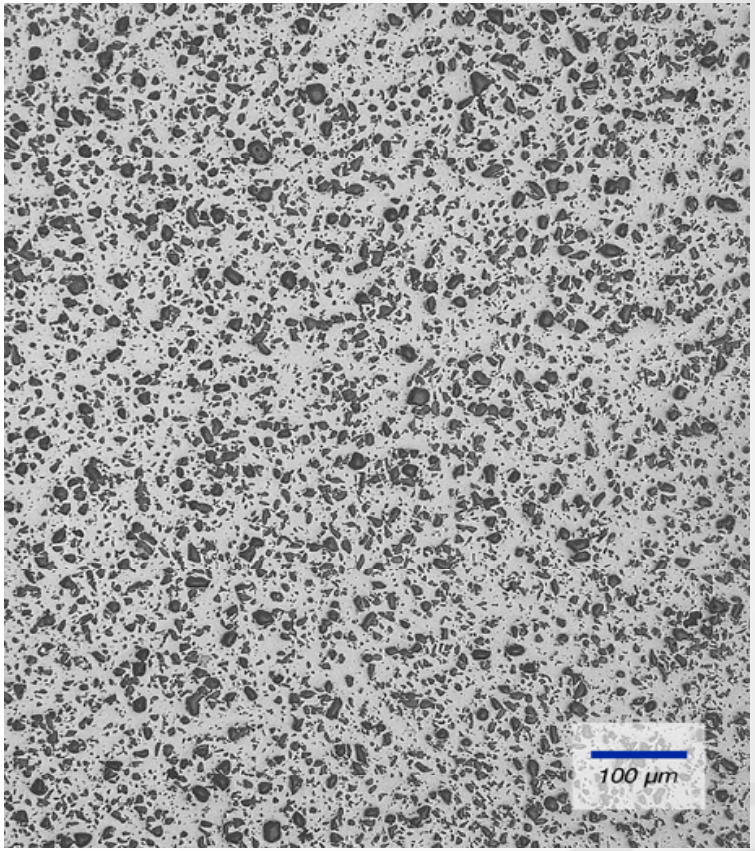
Aluminum Metal Matrix Composite

- Ceradyne, Inc.
- Quebec, Canada
- www.ceradyneboron.com/products
- 1000, 5000 & 6000 Aluminum Alloy Matrix
- B_4C content up to 45 vol.%
- Available as billet or sheet
- Not in service in US commercial reactor spent fuel pools
- Corrosion performance testing data – Ref. 3

Metamic®

Aluminum Metal Matrix Composite

- Holtec International
  - Marlton, NJ
- Metamic LLC
  - Lakeland, FL
- www.metamic.com
- 6061 Aluminum Alloy Matrix
- Boron content up to 33 wt.%
- Available as extrusion, sheet, forgings and drawn
- In use in US commercial reactor spent fuel pools
- Corrosion performance testing data – Ref. 3



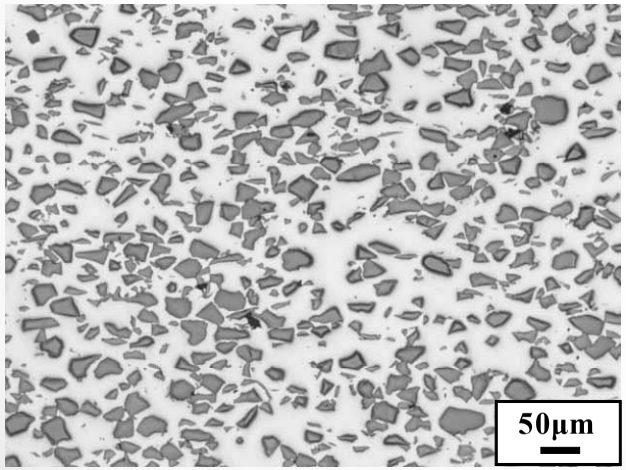
6061+21% Boron Carbide

MAXUS™

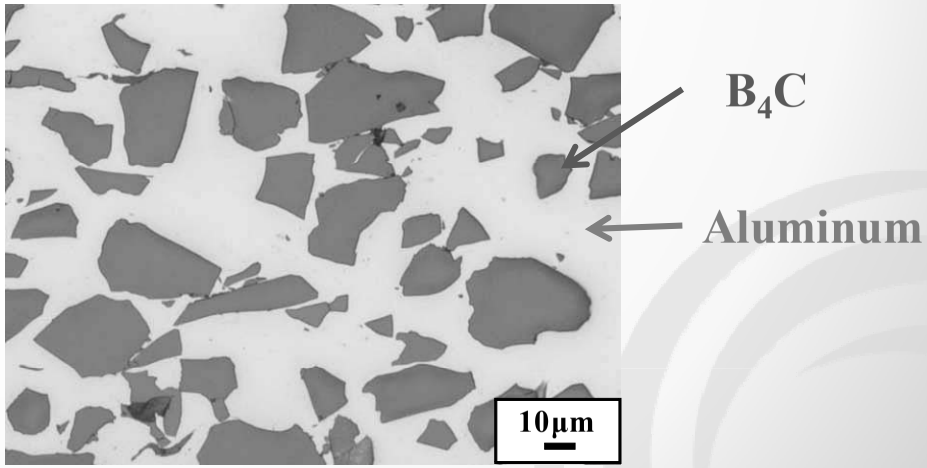
Hybrid Aluminum Metal Matrix Composite

- Aluminum Core Technology
- Tokyo, Japan
- www.nlmetal.com/solutions
- B_4C in core 21-40 wt.%
- Available as sheet

- Clad Metal Matrix Composite
  - Aluminum Core
  - 5052 Aluminum Alloy Clad
- Not in service in US commercial reactor spent fuel pools
- 8000 hour accelerated corrosion test (proprietary)



×100

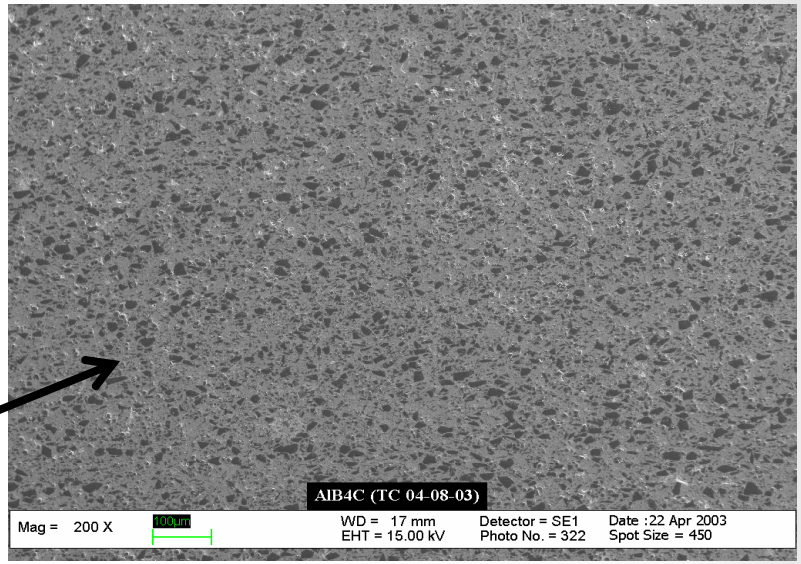


×400

Talbor®

Aluminum Metal Matrix Composite

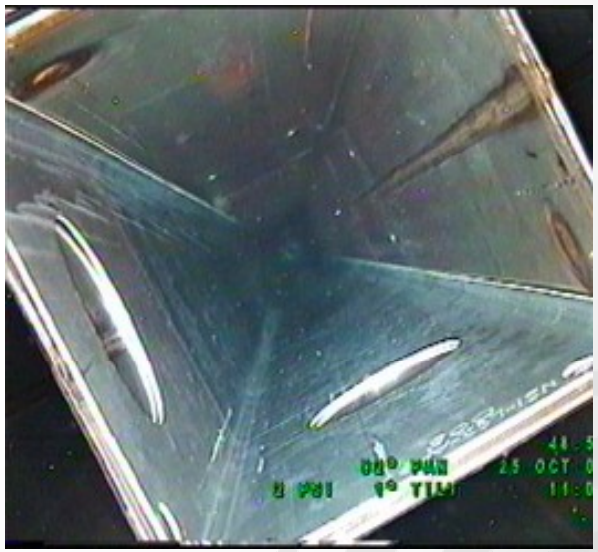
- Talon Composites, LLC
- San Juan Capistrano, CA
- www.taloncomposites.com
- Available as 1100 or 6092 Aluminum Alloy Matrix for nuclear applications
- B_4C 1-40 vol.%
  - 29.2 wt.% B_4C @ 200x
- Available as sheet, extruded cross sections, rolling & forging blanks
- Not in service in US commercial spent fuel pools
- Corrosion testing to support dry storage application – Ref. 3



W110N.XXB

Aluminum Metal Matrix Composite

- Rio Tinto Alcan
- Quebec, Canada
- www.rtapublicsales.riotinto.com
- Aluminum 1100 Alloy Matrix
- Boron content
  - For US spent fuel pool applications: 16-40 vol.%
- Available as billet or sheet
- In use at LaSalle Unit 2 as SNAP-IN® spent fuel pool inserts
- Corrosion performance testing data – Ref. 4
  - Submitted as part of LaSalle & Peach Bottom LAR



Corrosion Performance References

Open Literature

1. “Electrochemical Corrosion Testing of Neutron Absorber Materials,” Lister, T., et al, May 2007, Idaho National Laboratory, INL/EXT-06-11772, Rev. 1
2. “ATI 304B7 P/M™ Alloy Technical Data Sheet,” ATI Nuclear Energy, 12/2/11
3. “Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications, 2009 Edition,” EPRI, TR 1019110, November 2009
4. “Material Qualification of Alcan Composite for Spent Fuel Storage,” Northeast Technology Corp., NET-259-03, Rev. 5, August 2008