Alloying aluminium and high technology

BORALCAN™ is a Metal Matrix Composite: An aluminium alloy with nuclear grade $\text{B}_4\text{C}$ addition for use as neutron absorbing material for

- Spent Fuel Dry Storage Basket in form of rolled strip or extruded shapes.
- Spent Fuel Wet pool Rack shielding in form of rolled strip.

Metal Matrix Composites (MMCs)

Aluminium matrix composites containing reinforcing ceramic particles such as SiC, $\text{B}_4\text{C}$ and others have been historically used in a range of high performance applications such as transportation components, aircraft and aerospace structures, medical devices and neutron-shielding components. BORALCAN™ MMCs are attractive due to their special capability to capture neutrons along with their low density, superior stiffness and strength. Initially, widespread use of $\text{B}_4\text{C}$ particle reinforced composite materials was limited due to their complex production routes.

Based on many years of experience in the manufacture of aluminium-based MMC materials, Rio Tinto Alcan has developed a novel liquid mixing process and associated downstream fabrication technologies for the production of BORALCAN™ which can now be cast, extruded or rolled into almost any desired shape. A family of BORALCAN™ materials incorporating a range of Al matrix alloys and $\text{B}_4\text{C}$ loadings is now available for use in a broad range of applications.

Common BORALCAN™ alloy matrix used are W1100N.xxB, W6351N.xxB which are based on AA 1100 and AA 6351 composition limits.
BORALCAN™ product characteristics

**LARGE BATCH SIZE:** Excellent uniformity of B₄C distribution.

**STIFFER:** Young Modulus, higher than standard alloys (105 vs 69 GPa) due to cohesion between the particles and the aluminium alloy matrix.

**WELDABLE:** Using friction stir welding

**DRYABLE:** 100% dense, no porosity, uniform structure across the whole thickness.

**BENDABLE:** Best bending characteristics are achieved with alloy W1100N.xx8 in O temper condition:

Due to the nature of the material, BORALCAN™ exhibits the superior bending capabilities to alternate MMC products. B₄C content, sheet thickness and bend radius are the key parameters impacting the bend performance.

**CORROSION RESISTANCE:**
- Very good, similar to AA 1200
- MEASURED WITH ACCELERATED CORROSION TEST
  - BWR and PWR pool environment
  - In contact with 304L, Inconel 718, Zircaloy
  - 16% and 25% B₄C, bent sheet
  - Up to 8000 hrs at 195°F, equivalent to 17 years at 80°F

**MAIN CONCLUSIONS:**
- Typical corrosion rate: -0.01-0.04 mills/year
- Identical corrosion rate for BORALCAN™ 16% and 25% B₄C
- No differences between BWR and PWR environment
- No difference when exposed to galvanic conditions
- No local or pitting corrosion observed

BORALCAN™ process development

**B₄C POWDER**
- Nuclear grade boron carbide with tight control of the particle sizes
- Nuclear grade boron carbide certified for ¹⁰⁶B

**LIQUID MIXING PROCESS**

**MAIN FEATURES:**
- Efficient process for large-scale production
- Rio Tinto Alcan has patented the process ensuring a homogenous distribution of the B₄C powder incorporated into Al
- Strong interfacial bond between particulate and aluminium alloy matrix
- B₄C loading can vary over a wide range
  - 4.5% to 18% v/v B₄C for extruded products
  - 16% to 30% v/v B₄C for rolled products

---

Dubuc Works  |  2040, Chemin de la Réserve, Saguenay (Quebec) CANADA  G7H 5B3
Montreal sales office  |  1188, Sherbrooke street west, Montreal (Quebec) CANADA  H3A 3G2  |  Phone : 1 514 848 8000  |  Fax : 1 514 848 1367