

3M Advanced Materials Division

3M™ Antioxidants for Carbon-Bonded Refractories

Introduction

Carbon is used in refractory materials to improve thermal shock resistance and to protect against wetting by metals and slag. Carbon bonded refractories also have the best chemical resistance against molten steel. However, they are sensitive to oxidation and require extra protection. 3M offers a family of ceramic-based powders as antioxidants for carbon-bonded refractories. While metallic additives are very common, ceramic antioxidants have proven to be more effective at prolonging the service life of carbon bonded refractory materials.

Typical Chemical Composition

(Not for specification purposes.)

B₄C	
B + C	>95%
C _{free}	<4%
N	<2%

CaB₆	
Ca + B	>87%
C	<6%

ZrB₂	
Zr + B	>95%
C	<1.5%



Grains and Powders



3M™ Boron Carbide



3M™ Calcium Hexaboride



3M™ Zirconium Diboride 1-3 mm

3M™ Boron Carbide (B₄C) Powders

When oxidized, an interaction occurs with the matrix material to form liquid and/or gaseous phases that protect the carbon from oxidation. This material has a proven track record for use with carbon-bonded aluminum oxide (Al₂O₃-C) slide gates and various isostatically pressed components and monolithics.

3M™ Calcium Hexaboride (CaB₆) Powders

This material is primarily used for carbon-bonded magnesium oxide (MgO) bricks and monolithics in steel production.

3M™ Zirconium Diboride (ZrB₂) Powders

This is the best known additive for improving corrosion resistance in zirconia-based, carbon-bonded refractories that come into contact with ferrous melts, e.g. submerged entry nozzles.

Grain Size Distribution

(Not for specification purposes)

Property	3M™ Antioxidants		
	B ₄ C	CaB ₆	ZrB ₂
Particle Size Mesh	-100	-400	-400
3%-Value (minimum 97%)	<56 μm	<56 μm	<56 μm
50%-Value (average)	3 – 15 μm	9 – 17 μm	6 – 17 μm
94%-Value (maximum 6%)	<1 μm	<5 μm	<5 μm

Measured with laser diffractometer, Coulter LS 13320. Additional coarser or finer grain sizes on request.

Typical Physical Properties

(Not for specification purposes)

Property	3M™ Antioxidants		
	B ₄ C	CaB ₆	ZrB ₂
Crystal Structure	rhombohedral	cubic	hexagonal
Molecular Weight	55.26 g/mol	104.95 g/mol	112.845 g/mol
Density	2.54 g/cm ³	2.45 g/cm ³	6.09 g/cm ³
Melting Point	2,450°C 4,440°F	2,185°C 3,965°F	2,990°C 5,415°F
Hardness (Mohs scale)	9	8 – 9	8
Thermal Expansion (20 – 1,000°C)*	5 × 10 ⁻⁶ /K	6.5 × 10 ⁻⁶ /K	6.6 × 10 ⁻⁶ /K

* measured on dense shapes

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The management system has been certified according to DIN EN ISO 9001, DIN EN ISO 50001, DIN EN ISO 14001.



3M Technical Ceramics

Zweigniederlassung der 3M Deutschland GmbH
Max-Schaidhauf-Str. 25, 87437 Kempten, Germany

Phone +49 (0)831 5618-0
Email info.technical-ceramics@3M.com
Web www.3M.de/Technical-Ceramics

3M Advanced Materials Division

3M Center
St. Paul, MN 55144 USA

Phone 1-800-367-8905
Web www.3M.com/advancedceramics

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