

# 3M™ Antioxidants for Carbon-Bonded Refractories

Carbon in refractory materials improves thermal shock resistance, protects against wetting from metals and slag, and requires extra protection from oxidation. Carbon bonded refractories have the best chemical resistance against molten steel. However they are sensitive to oxidation.



Grains and powders



3M™ Boron Carbide

## Application

Metallic additives are very common but ceramic antioxidants are proven more effective. When 3M™ Boron Carbide ( $B_4C$ ) is oxidized, an interaction occurs with the matrix material to form liquid and / or gaseous phases protecting the carbon from oxidation, thereby prolonging the service life of carbon-bonded refractory materials.

3M™ Calcium Hexaboride ( $CaB_6$ ) is primarily used for carbon-bonded MgO based bricks and monolithics in the steel making processes.

3M™ Zirconium Diboride ( $ZrB_2$ ) is the best additive for improving corrosion resistance in zirconia based carbon-bonded refractories coming into contact with ferrous melts, e.g. submerged entry nozzles.

## Chemistry (typical values)

$B_4C$	
B + C	> 95%
$C_{free}$	< 4%
N	< 2%

$CaB_6$	
Ca + B	> 87%
C	< 6%

$ZrB_2$	
Zr + B	> 95%
C	< 1,5%



3M™ Calcium Hexaboride



3M™ Zirconium Diboride 1-3 mm

Grain size distribution (typical values)			
Material	B <sub>4</sub> C	CaB <sub>6</sub>	ZrB <sub>2</sub>
Particle size mesh	- 100	-400	-400
3%-value (min. 97%)	< 56 µm	< 56 µm	< 56 µm
50%-value (average)	3 – 15 µm	9 – 17 µm	6 – 17 µm
94%-value (max. 6%)	< 1 µm	< 5 µm	< 5 µm

(Measured with laser diffractometer, Coulter LS 13320)

**Additional coarser or finer grain sizes on request.**

Properties			
	B <sub>4</sub> C	CaB <sub>6</sub>	ZrB <sub>2</sub>
Chemical formula	B <sub>4</sub> C	CaB <sub>6</sub>	ZrB <sub>2</sub>
Crystal structure	rhombohedral	cubic	hexagonal
Molecular weight	55.26 g/mol	104.95 g/mol	112.845 g/mol
Density	2.54 g/cm <sup>3</sup>	2.45 g/cm <sup>3</sup>	6.09 g/cm <sup>3</sup>
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 <sup>-6</sup> /K	6.5 · 10 <sup>-6</sup> /K	6.6 · 10 <sup>-6</sup> /K

\* measured on dense shapes

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**3M Technical Ceramics**  
 Zweigniederlassung der  
 3M Deutschland GmbH  
 Max-Schaidhauf-Straße 25  
 87437 Kempten, Germany  
 T +49 (0)831 5618-0  
 F +49 (0)831 5618-345  
 info.technical-ceramics@3M.com  
 www.3M.de / Technical-Ceramics

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