Why zinc borates?
Studies have shown that zinc borates function as flame retardants, smoke suppressants, afterglow suppressants, and anti-tracking agents in both halogen-containing and halogen-free polymers.

Multi-functional flame retardant for polymers
In halogen free systems, zinc borates can be used either alone or in combination with other flame retardants such as metal hydroxides (ATH, MDH), phosphorus, and silicone. They promote:

- Char/residue formation
- Stabilization of the char and inhibition of the oxidation of the char (afterglow suppression)
- Smoke suppression

In halogen containing systems, zinc borates are synergist of halogen sources. They can function both as a smoke suppressant and as an afterglow suppressant. And, studies show that they can also improve thermal stability and provide anti-tracking and anti-arcing properties.

In addition, zinc borates:
- Release water to provide additional flame retardancy
- Provide corrosion resistance

Lower cost alternative to antimony oxide
The lower cost Firebrake zinc borates can partially or completely replace more expensive antimony oxide in many flame retardant formulations—resulting in better flame retardancy and lower smoke.

Versatility across polymer types
Zinc borates are used in a wide range of polymers:
- Polyvinyl chloride (PVC)
- Polyamide (nylon)
- Polyolefin

- Epoxy
- Acrylics
- Phenolics
- Siloxanes
- Polyether sulfones
- Various elastomers

Why U.S. Borax Firebrake ZB and Firebrake 500?
Consistency, quality, and reliability
The borate raw materials used in our Firebrake products comes from our world-class mine in Boron, California. The refining process results in the high-quality, dependable products you’ve come to expect from U.S. Borax.

- Consistent round particle shape for potentially improved powder flow
- Consistent bulk density and particle size distribution
- Produced from, refined zinc oxide and boric acid to reduce impurity levels
- Supply reliability: Our extensive distribution network ensures a regular supply to meet your needs

Technical expertise
U.S. Borax has decades of institutional knowledge about the use of zinc borates in polymers.

- We pioneered the use of zinc borates as fire retardants
- Our experts are advancing the science of zinc borates through continuing research

A global, multi-lingual technical support team can provide advice on formulation and process troubleshooting
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Firebrake ZB and Firebrake 500</th>
<th>Certain other zinc borates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impurities</td>
<td>Product tests consistently result in tight specifications and lower impurities levels due to:</td>
<td>High impurity levels in some unrefined zinc borate products can lead to:</td>
</tr>
<tr>
<td></td>
<td>- Boric acid mined and refined in the United States</td>
<td>• Lower flammability performance</td>
</tr>
<tr>
<td></td>
<td>- Only using high-quality zinc oxide</td>
<td>• Higher heavy metal levels such as lead—which can be a concern in some applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Corrosion in production with high sulfate and chloride content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase in ionic conductivity due to high chloride, sulfate, and sodium content which can</td>
</tr>
<tr>
<td></td>
<td></td>
<td>be an issue for electrical/electronic applications</td>
</tr>
<tr>
<td>Morphology</td>
<td>• Consistent crystal morphology over a 40 year period</td>
<td>Variation and inconsistencies in particle shape between and among other products may impact:</td>
</tr>
<tr>
<td></td>
<td>• Round micro-crystalline agglomerates for consistent powder flow</td>
<td>• Flow in feeding process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Processing into polymer requiring higher energy use and poor particle distribution</td>
</tr>
<tr>
<td>Thermal stability</td>
<td>• Firebrake ZB is thermally stable to 290°C</td>
<td>• May contain impurities that reduce thermal stability of the polymer</td>
</tr>
<tr>
<td></td>
<td>• Firebrake 500 is thermally stable to 600°C</td>
<td>• Hydrous zinc borates cannot be used for high processing temperature polymers</td>
</tr>
<tr>
<td>Bulk density</td>
<td>High and consistent bulk density at 45-55 pcf allows for reliable feeding and processing</td>
<td>Low and inconsistent bulk density ranging from 15-40 pcf</td>
</tr>
</tbody>
</table>

**Firebrake ZB**

The more rounded particle shape of U.S. Borax Firebrake zinc borate products promotes consistent powder flow, process handling, and distribution in the product.

**Firebrake 500**

An example of zinc borate with a platy open particle structure. It could reduce powder flowability and bulk density—potentially affecting process handling and distribution.

**Other zinc borate on the market**

An example of zinc borate with a platy open particle structure. It could reduce powder flowability and bulk density—potentially affecting process handling and distribution.
Notice: The above data is subject to change from time to time at the discretion of the U.S. Borax. Although the data listed above are typical, they are not production specifications and are not warranted. To obtain exact production specifications, please contact U.S. Borax. The data presented are based upon tests that U.S. Borax believes to be reliable and are offered in good faith as typical of normal production, but U.S. Borax makes no warranty or representation of any kind, express or implied, regarding the information given or the product described, including any warranty of suitability for a particular purpose or use.

<table>
<thead>
<tr>
<th>Description</th>
<th>Firebreak ZB</th>
<th>Firebreak ZB Fine</th>
<th>Firebreak ZB-XF</th>
<th>Firebreak 500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formula</strong></td>
<td>2ZnO·3B₂O₃·3.5H₂O</td>
<td>2ZnO·3B₂O₃·3.5H₂O</td>
<td>2ZnO·3B₂O₃·3.5H₂O</td>
<td>2ZnO·3B₂O₃</td>
</tr>
<tr>
<td><strong>ZnO</strong></td>
<td>37.7-38.7%</td>
<td>37.7-38.7%</td>
<td>37.7-38.7%</td>
<td>43.5 - 45.5%</td>
</tr>
<tr>
<td><strong>B₂O₃</strong></td>
<td>47.5-48.9%</td>
<td>47.5-48.9%</td>
<td>47.5-48.9%</td>
<td>53.5 - 55.5%</td>
</tr>
<tr>
<td><strong>H₂O</strong></td>
<td>14%</td>
<td>14%</td>
<td>14%</td>
<td>--</td>
</tr>
</tbody>
</table>

**Typical median particle size**
- **Firebreak ZB Fine and Firebreak ZB-XF** are recommended for applications where maximum fire test performance is needed, and physical properties such as film forming and adhesion are critical.

- **Firebreak 500** is thermally stable up to 600° C and is used in high processing temperature polymers such as nylon 66 and polyethersulfone.

**About U.S. Borax**

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates—naturally-occurring minerals containing boron and other elements. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world’s need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles. We pioneer the elements of modern living, including:

- **Minerals that make a difference:** Consistent product quality secured by ISO 9001:2015 registration of its integrated quality management systems
- **People who make a difference:** Experts in borate chemistry, technical support, and customer service
- **Solutions that make a difference:** Strategic inventory placement and long-term contracts with shippers to ensure supply reliability