

ALMABOR[®]

ENABLING NEW FRONTIERS IN ORGANOBORON CHEMISTRY



ANDERSON DEVELOPMENT COMPANY

A SPECIALTY CHEMICAL COMPANY

Anderson Development Company, a wholly-owned subsidiary of Mitsui Chemicals, is an award-winning, innovative specialty and custom chemical manufacturer. Anderson Development Company is committed to providing value-added solutions through research and development capabilities, superior products and by being personal, efficient, and responsive to customers and employees.

Since our founding in 1967, Anderson Development Company has been moving forward aggressively on many fronts to capitalize on solid growth opportunities, to expand global presence and to sharpen product offerings. Through extensive research, development and manufacturing capabilities and our parent company's "Global Body of Knowledge," Anderson Development Company is able to offer innovative specialty and custom chemicals which help improve the quality of life for our customers while typically reducing the impact to our environment.

To show this commitment, Anderson Development Company supports the American Chemical Council's Responsible Care program, the chemical industry's initiative to continually improve health, safety, security, and environmental performance worldwide.

The key to success at Anderson Development Company has always been our people who strive to meet and exceed our customer's expectations. The strong team of dedicated professionals at Anderson Development Company does more than just make products; they provide solutions for our customers. For over 37 years, Anderson Development Company's dedication to excellence has created long-term relationships with a wide range of companies -- from smaller domestic firms to large international Fortune 500 companies.

QUALITY & CUSTOMER SATISFACTION

At Anderson Development Company, we are committed to enhancing the "Quality of Life" for our employees and stakeholders through the continuous improvement of performance in:

- Health, safety and security
- Environmental protection through pollution prevention
- Customer satisfaction
- Meeting regulatory requirements and other agreed upon commitments
- Supporting Responsible Care®

The underlying philosophy is continuous improvement of the various aspects of our integrated management system.

Anderson Development Company has maintained its entrepreneurial and developmental spirit while evolving into a global manufacturer using the systematic ISO 9000,

ISO 14000, RC14000, cGMP and SEMI work processes needed to exceed the expectations of Quality, Safety, Environmentally focused industries like the top tier Automotive, Pharmaceutical, and Semiconductor Manufacturers, while remaining globally cost competitive. Our systems are confirmed with audits by pharmaceutical and electronics innovators to ensure quality and supply is a certainty.

To achieve total customer satisfaction, we do our best to understand customer's requirements and meet those requirements at all times. While customer satisfaction is one of the main aspects of our management system, our commitment extends beyond customer satisfaction. We will also strive to do everything right the first time and do our best to continually improve. Improving our process efficiencies and effectiveness is of primary importance to us as a business entity.



ALMABOR®

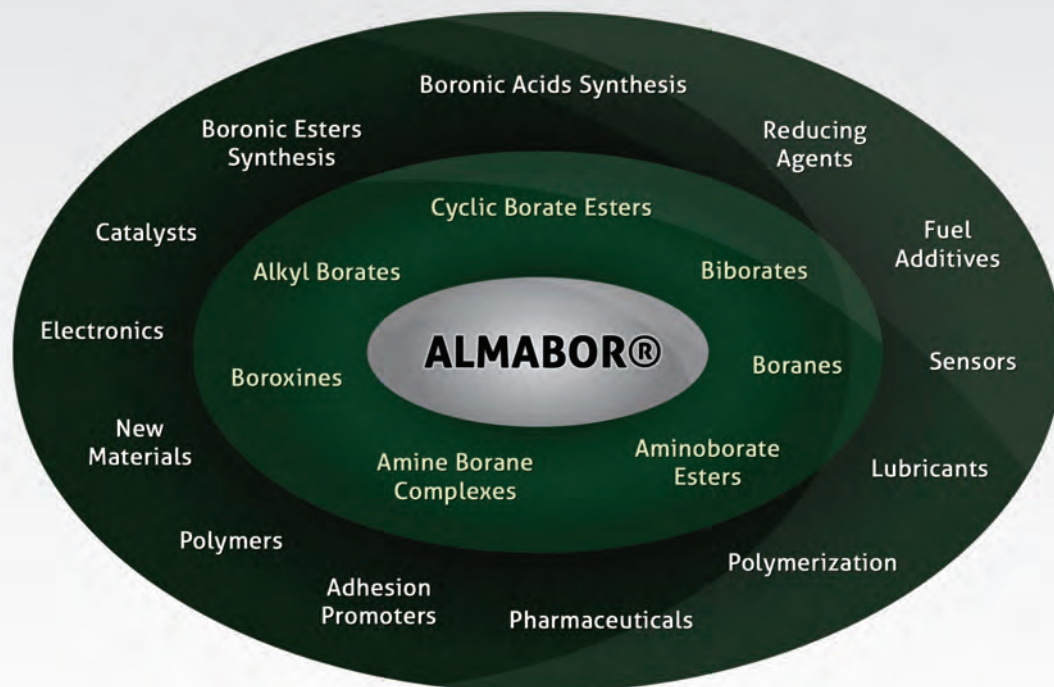
ENABLING NEW FRONTIERS IN ORGANOBORON CHEMISTRY

Anderson Development Company (ADC) is one of the world's largest merchant producers of specialty borate esters. ADC is a global supplier of a boron-based product line, Almabor®, which includes: triisopropyl borate (TiPB), triethyl borate (TEB), tri-n-butyl borate (TnBB) and many more. New offerings from ADC include boranes, amine boranes, dioxaborinanes, dioxaborolanes, biborate esters, trialkylaminoborates and boroxines. Many of ADC's high purity specialty borate esters can be used for manufacturing organoboronic acids and esters as well as organotrifluoroborates which have been utilized not only in a wide range of transition metal catalyzed reactions, for example Suzuki coupling, but also in other synthetically useful transformations. In addition, ADC serves a diverse range of highly specialized industries with boron applications that include electronic chip manufacturing, chemical intermediates, catalysts, fuel and lubricant additives, adhesion polymers, liquid crystal manufacturing and more.

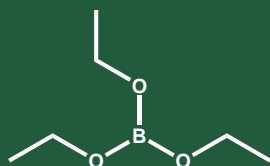
Almabor® products are known for high purity and consistency, offering greater cost efficiency, and improved yields. The use of Almabor® products can often offer more mild reaction conditions when compared to alternative synthetic routes. Ask us how we can help improve your routes through the use of Almabor® products.

Anderson Development Company offers R&D bench scale, kilo-scale, pilot plant and bulk manufacturing capabilities. Almabor® products are available for lab and commercial use and many of our Almabor® products are in stock for immediate delivery anywhere in the world.

From our headquarters, laboratories, pilot plant, two manufacturing facilities, warehousing and bulk storage facilities in Adrian, Michigan, ADC is positioned to develop and provide innovative solutions for even your most complex problems.



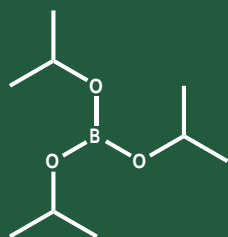
ALKYL BORATES



ALMABOR® TEB

Triethyl borate

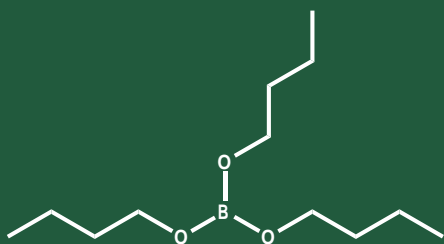
CAS# 150-46-9



ALMABOR® TIPB

Triisopropyl borate

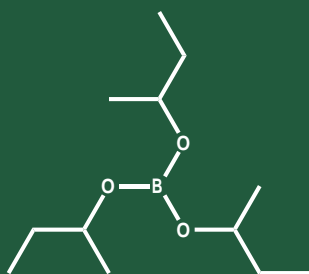
CAS# 5419-55-6



ALMABOR® TnBB

Tri-n-butyl borate

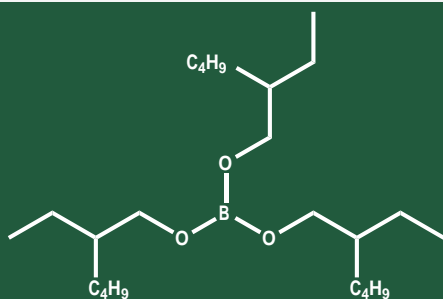
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ALMABOR® TsBB

Tri-sec-butyl borate

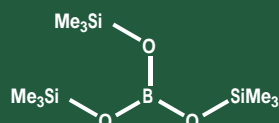
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ALMABOR® 2EHB

Tris-2-ethylhexyl borate

CAS# 2467-13-2

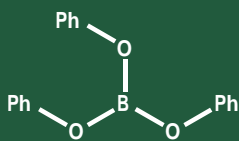


ALMABOR® TTMSB

Tris(trimethyl)silyl borate

CAS# 4325-85-3

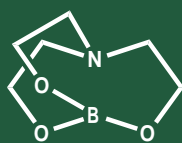
SPECIALTY ORGANOBORATES



ALMABOR® TPB

Triphenyl borate

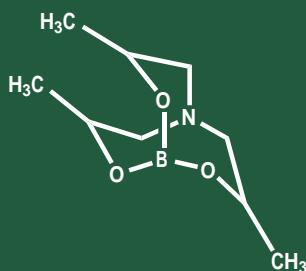
CAS# 1095-03-0



ALMABOR® TEAB

Triethanolamine borate

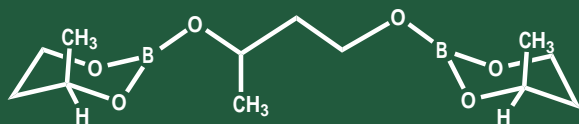
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ALMABOR® TIPAB

Triisopropanolamine borate

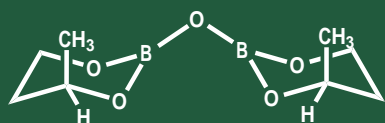
CAS# 101-00-8



ALMABOR® TBGBB

Tributylenglycol diborate

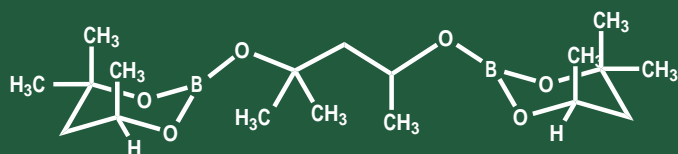
CAS# 2665-13-6



ALMABOR® 3541

Dibutylenglycol diborate

CAS# 26537-96-2



ALMABOR® THGBB

Trihexylenglycol diborate

CAS# 100-89-0

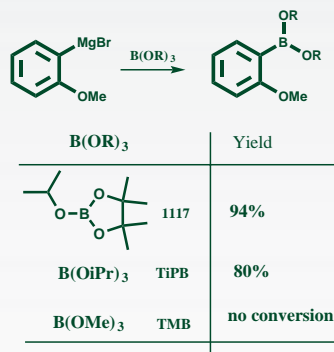
NEW CYCLIC BORATE ESTERS

BENEFITS OF ALMABOR BORATE ESTERS

- High Purity
- Efficient Chemistry Performance
- Custom Packaging
- Commercial Quantities
- Customization of products (many analogs available)
- Technical Support for handling and applications

Anderson Development Company offers a family of dioxaborinanes (six-member ring framework) and dioxaborolanes (five-member ring framework) for efficient synthesis of their corresponding organoboronates in one step under mild conditions.¹

Classical routes for the preparation of boronic acids involve utilization of Grignard or organolithium reagents with trialkyl borates. Although this is a great way to synthesize many boronic acids, it usually requires utilization of cryogenic technologies which make the processes ultimately less economically feasible, especially at larger scales. Furthermore, this process does not work well for many boronic acids due to their intrinsic instability, as some boronic acids tend to decompose to boroxines that are known to initiate and promote the auto-oxidation processes. Therefore the popularity of boronic acid esters as substitutes of boronic acids has continued to rise dramatically.⁴



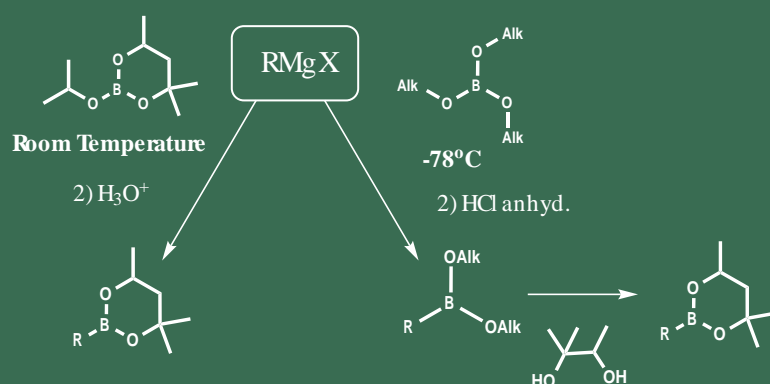
¹ Myslinska, M.; Heise, G. L.; Walsh, D. J. *Tetrahedron Lett.* **2012**, 53, 2937.

² Demory, E.; Blandin, V.; Einhorn, J.; Chavant P. Y. *Org. Process Res. Dev.* **2011**, 15, 710.

³ Hawkins, V. F.; Wilkinson, M. C.; Whiting, M. *Org. Process Res. Dev.* **2008**, 12, 1265.

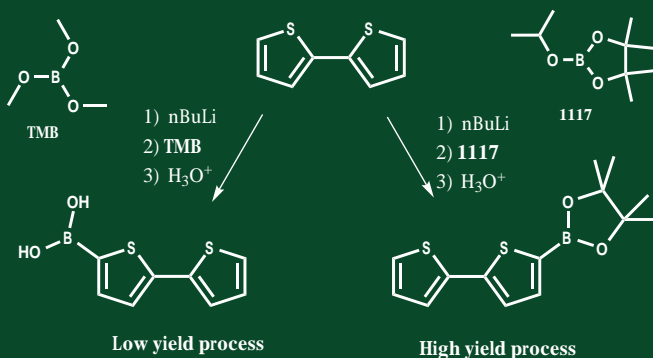
⁴ Hall, D. G. *Boronic Acids*, Wiley: New York, **2005**.

APPLICATIONS OF CYCLIC VS. ACYCLIC ESTERS



ADVANTAGES

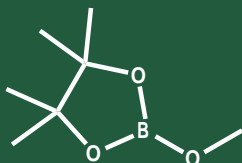
- The cyclic structure provides improved stability
- Easy scale up and use in large scale processing.^{2,3}
- Reaction with Grignard reagents can be performed at room temperature.¹
- React with organolithium reagents even at -20C.
- The corresponding boronates react in the transition metal catalyzed cross coupling reactions with excellent yields.



Low yield process

High yield process

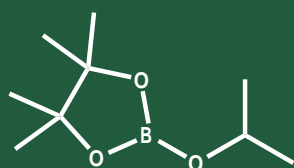
DIOXABORINANES & DIOXABOROLANES



ALMABOR® 0411

2-Methoxy-4,4,5,5-tetramethyl-[1,3,2]dioxaborolane

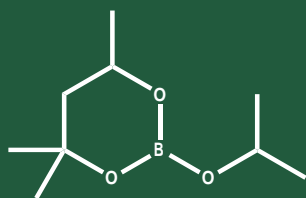
CAS# 1195-66-0



ALMABOR® 1117

2-Isopropoxy-4,4,5,5-tetramethyl-[1,3,2]dioxaborolane

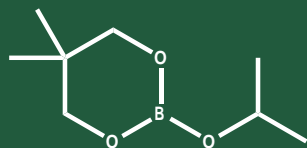
CAS# 61676-62-8



ALMABOR® 2111

2-Isopropoxy-4,4,6-trimethyl[1,3,2]dioxaborinane

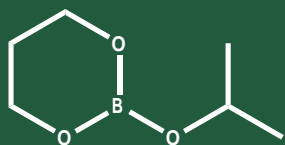
CAS# 61676-61-7



ALMABOR® 2409

2-Isopropoxy-5,5-dimethyl-[1,3,2]dioxaborinane

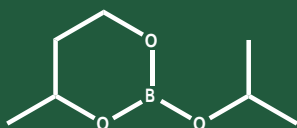
CAS# 81759-74-2



ALMABOR® 2043

2-Isopropoxy-[1,3,2]dioxaborinane

CAS# 90011-03-3



ALMABOR® 2547

2-Isopropoxy-4-methyl-[1,3,2]dioxaborinane

CAS# 71349-55-8

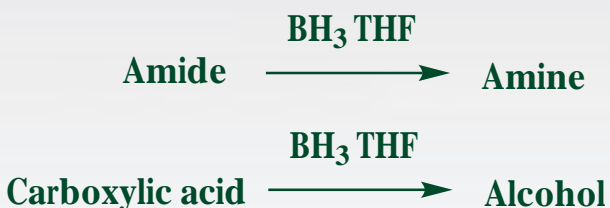
BORANES

BENEFITS OF ALMABOR BORANES

- Versatile Reducing Agents
- Excellent for Hydroborations
- High Purity
- Reliable Quality
- Efficient Chemistry Performance
- Custom Packaging
- Commercial Quantities
- Customization of products (many solvents at different concentrations)
- Technical Support for handling and applications

Borane reagents are versatile reagents commonly used in reductions of a variety of functional groups. The high performance of boranes in the reactions and simplicity of isolation of the reduced product make them favorite reagents for a number of industrial applications.

Borane THF (BTHF) is particularly useful for selective reductions of carboxylic acid to alcohols in the presence of esters. Amides are also readily reduced to corresponding amines.

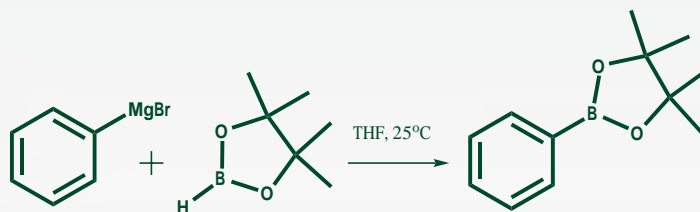


Borane THF is a very labile complex therefore quite reactive, and it serves as valuable reagent for hydroboration with carbon-carbon double and triple bonds. The most interesting application of BTHF is as a borane source for oxazaborolidine catalyzed asymmetric reductions of ketones known as Corey-Bakshi-Shibata (CBS) reduction.¹



Pinacolborane and Catecholborane are extensively used for catalytic hydroboration as well. It provides a simple access to alkyl and alkenyl boronic acids/esters for the Suzuki cross-coupling reaction.

Recently a very elegant synthesis of pinacolboronates was developed by employing aliphatic, aromatic, heteroaromatic, vinyl, or allylic Grignard reagents with pinacolborane at ambient temperature in THF.²



¹ Corey, E. J.; Shibata, S.; Bakshi, R. K. *J. Org. Chem.*, **1988**, *53*, 2861.

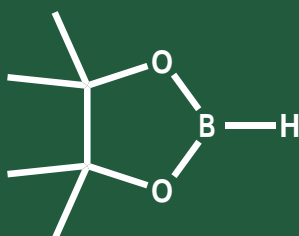
² Clary, J. W.; Rettenmaier, T. J.; Snelling, R.; Bryks, W.; Banwell, J.; Wipke, W. T.; Singaram, B. *J. Org. Chem.*, **2011**, *76*, 9602.

BORANES



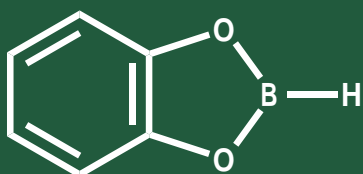
BORANE -TETRAHYDROFURAN COMPLEX ALMABOR® BTHF CAS# 14044-65-6

1.0M THF, stabilized with NaBH₄
Refrigeration Required.



PINACOLBORANE ALMABOR® PinB CAS# 25015-63-8

Neat, stabilized with NEt₃
1.0M THF, stabilized with NEt₃



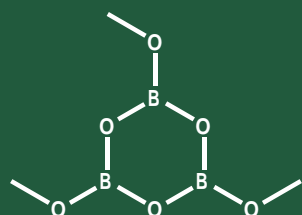
CATECHOLBORANE ALMABOR® CatB CAS# 274-07-7

Neat 98%
50% w/w in toluene
Refrigeration Required.

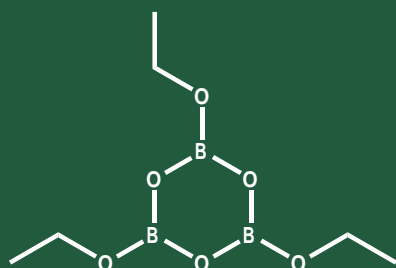
APPLICATIONS

- Excellent reagents for organic synthesis
- Reductions of functional groups (amide, carboxylic acids, ketones, aldehydes, amide etc.)
- Hydroboration reaction with alkenes and alkynes
- Palladium catalyzed borylation of organic halides
- Synthesis of boronates under Barbier conditions

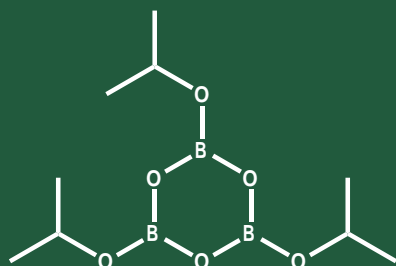
BOROXINES



TRIMETHOXYBOROXINE
ALMABOR® TMBX
CAS# 102-24-9



TRIETHOXYBOROXINE
ALMABOR® TEBX
CAS# 7325-11-3



TRIIISOPROPOXYBOROXINE
ALMABOR® TiPBX
CAS# 10298-87-0

APPLICATIONS

- Lithium Ion Battery Materials
- Flame Retardants
- Epoxy Resin Curing Agents
- Adhesion Promoters
- Lubricants and Anti-wear Additives
- Non-linear Optical Materials
- High Frequency Transducers
- Zeolite Additives



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