

Vol. 2, No. 1



ChemFiles

Boronic Acids

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Diboron Esters

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The synthesis of biaryl compounds by reaction of aryl halides with arylboronic acids, commonly referred to as the Suzuki coupling,¹ is an important area of growth. Of the wide variety of cross-coupling reactions, Suzuki coupling is the most general and widely used. Arylboronic acids are the favored reagents due to their stability, low toxicity, and limited side reactions. This brochure contains a comprehensive selection of boronic acids, boronic acid esters, diboron esters, and transition-metal catalysts useful for the Suzuki coupling reaction. New offerings are added monthly; if you don't see the material you need for your research, please call us at 1-800-231-8327 (USA) or your local office. Your new product suggestions, as always, are welcome and appreciated.

For additional technical information, please phone our Technical Services Department at 1-800-231-8327 (USA) or inquire via the Web at www.sigma-aldrich.com.

Boronic Acids

Aldrich is pleased to present its complete selection of boronic acids, the building blocks of the Suzuki coupling reaction. Most boronic acids readily undergo dehydration reactions to give a cyclic (trimer) anhydride. Our selection of boronic acids may contain varying amounts of this cyclic anhydride. Fortunately, the acid and the anhydride work equally well in the Suzuki coupling reactions; thus, the two forms are generally regarded as equivalent.

55,656-4
C₃H₆BBrO₂

New!



1g
5g

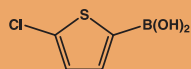
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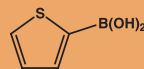
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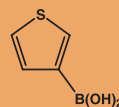
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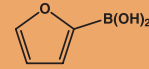
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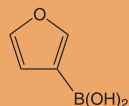
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51,216-8
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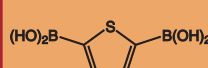
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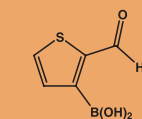
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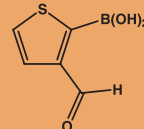
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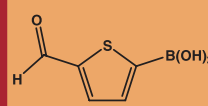
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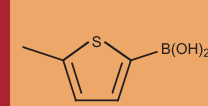
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1g
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C₅H₇BO₂S



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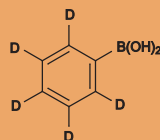
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New!



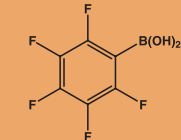
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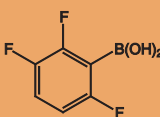
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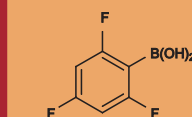
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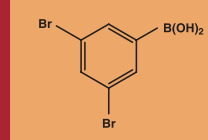
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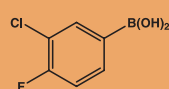
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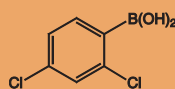
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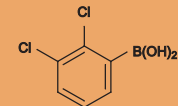
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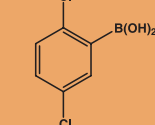
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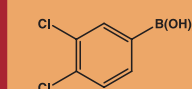
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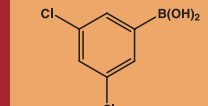
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C₆H₅BCl₂O₂



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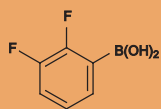
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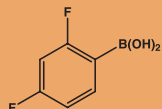
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51,403-9
C₆H₅BF₂O₂



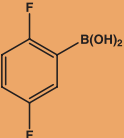
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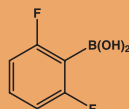
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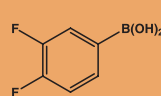
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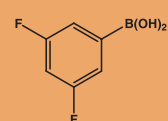
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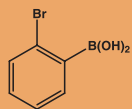
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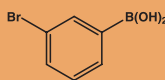
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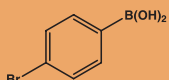
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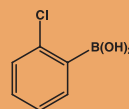
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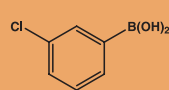
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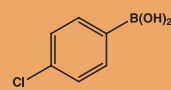
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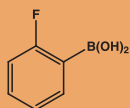
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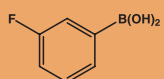
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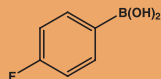
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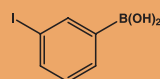
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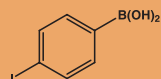
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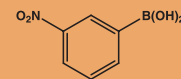
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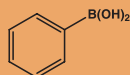
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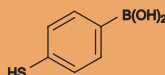
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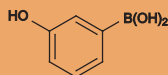
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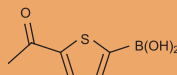
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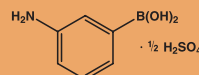
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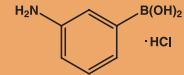
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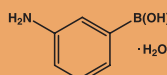
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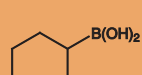
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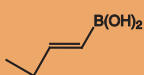
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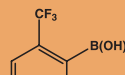
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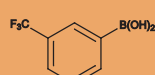
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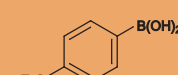
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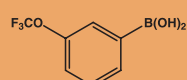
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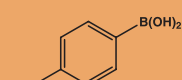
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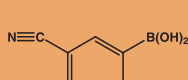
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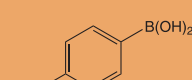
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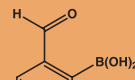
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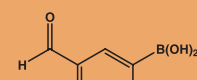
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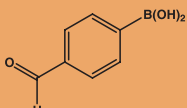
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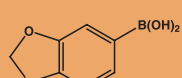
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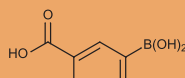
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C₇H₇BO₄



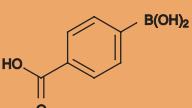
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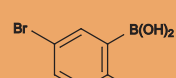
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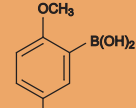
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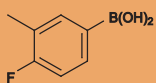
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C₇H₈BClO₃



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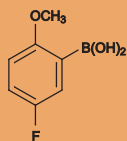
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48,356-7
C₇H₈BO₂



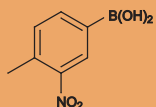
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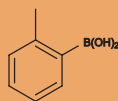
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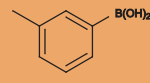
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39,360-6
C₇H₈BO₂



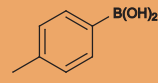
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39,361-4
C₇H₈BO₂



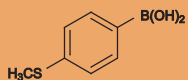
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39,362-2
C₇H₈BO₂



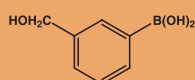
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45,680-2
C₇H₈BO₂S



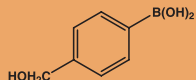
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51,283-4
C₇H₈BO₃



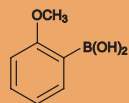
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51,233-8
C₇H₈BO₃



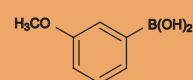
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44,523-1
C₇H₈BO₃



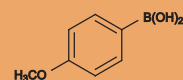
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44,168-6
C₇H₈BO₃



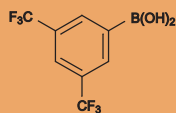
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41,759-9
C₇H₈BO₃



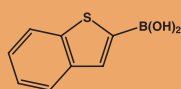
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47,107-0
C₈H₅BF₃O₂



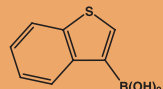
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49,997-8
C₈H₇BO₂S



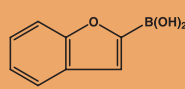
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51,211-7
C₈H₇BO₂S



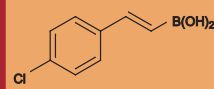
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49,994-3
C₈H₇BO₃



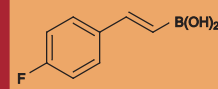
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52,356-9
C₈H₈BClO₂



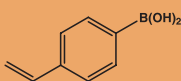
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51,897-2
C₈H₈BFO₂



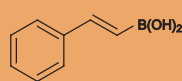
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41,758-0
C₈H₈BO₂



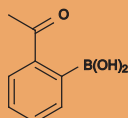
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47,379-0
C₈H₈BO₂



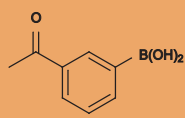
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47,080-5
C₈H₈BO₃



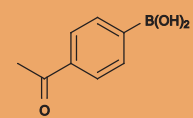
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47,081-3
C₈H₈BO₃



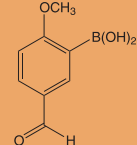
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47,082-1
C₈H₈BO₃



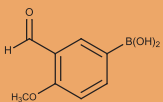
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51,225-7
C₈H₈BO₄



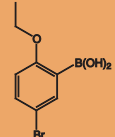
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51,286-9
C₈H₈BO₄



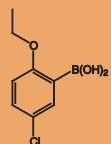
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51,282-6
C₈H₁₀BBrO₃



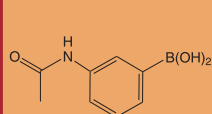
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54,254-7
C₈H₁₀BClO₃



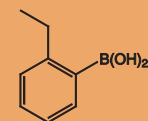
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56,601-2
C₈H₁₀BNO₃



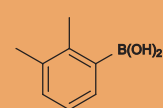
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52,152-3
C₈H₁₁BO₂



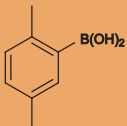
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48,350-8
C₈H₁₁BO₂



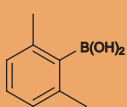
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48,351-6
C₈H₁₁BO₂



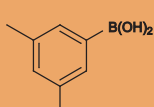
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48,006-1
C₈H₁₁BO₂



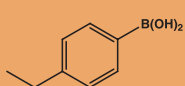
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48,008-8
C₈H₁₁BO₂



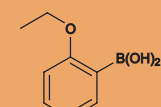
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49,953-6
C₈H₁₁BO₂



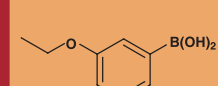
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45,552-0
C₈H₁₁BO₃



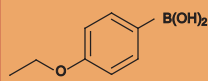
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44,163-5
C₈H₁₁BO₃



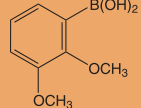
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45,553-9
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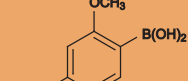
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55,773-0
C₈H₁₁BO₄



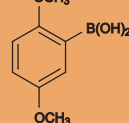
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48,348-6
C₈H₁₁BO₄



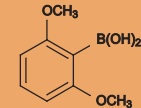
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48,349-4
C₈H₁₁BO₄



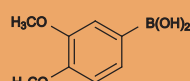
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48,009-6
C₈H₁₁BO₄



5g
25g

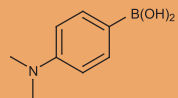
48,011-8
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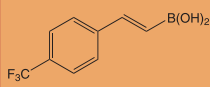
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48,353-2
C₈H₁₂BNO₂



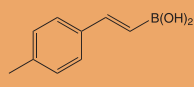
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51,902-2
C₉H₈BF₃O₂



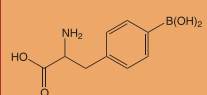
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56,813-9
C₉H₁₁BO₂



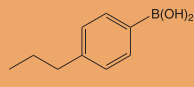
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51,268-0
C₈H₁₂BNO₄



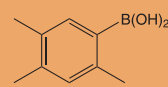
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52,150-7
C₉H₁₃BO₂



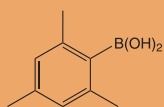
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54,232-6
C₉H₁₃BO₂



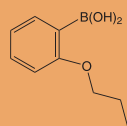
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54,231-8
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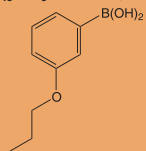
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55,772-2
C₉H₁₃BO₃



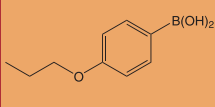
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55,771-4
C₉H₁₃BO₃



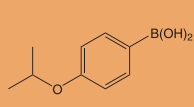
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55,770-6
C₉H₁₃BO₃



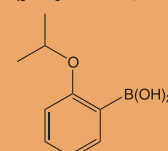
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54,247-4
C₉H₁₃BO₃



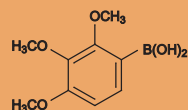
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54,246-6
C₉H₁₃BO₃



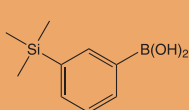
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51,228-1
C₉H₁₃BO₅



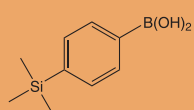
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52,366-6
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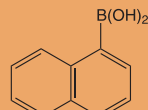
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52,367-4
C₉H₁₅BO₂Si



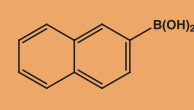
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N25-7
C₁₀H₉BO₂



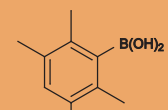
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48,013-4
C₁₀H₉BO₂



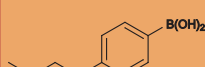
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52,151-5
C₁₀H₁₅BO₂



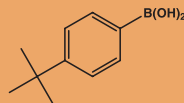
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52,149-3
C₁₀H₁₅BO₂



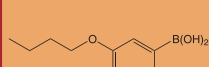
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48,005-3
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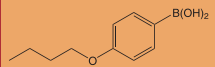
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54,249-0
C₁₀H₁₅BO₃



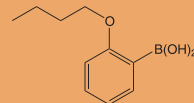
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54,250-4
C₁₀H₁₅BO₃



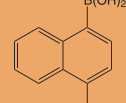
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54,248-2
C₁₀H₁₅BO₃



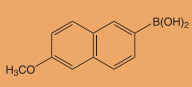
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52,145-0
C₁₁H₁₁BO₂



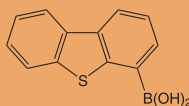
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52,189-2
C₁₁H₁₁BO₃



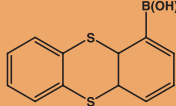
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49,998-6
C₁₂H₉BO₂S



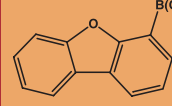
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51,221-4
C₁₂H₉BO₂S₂



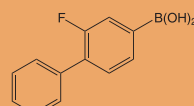
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49,995-1
C₁₂H₉BO₃



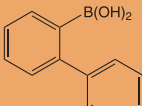
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51,210-9
C₁₂H₁₀BFO₂



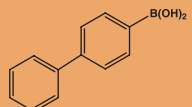
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54,220-2
C₁₂H₁₁BO₂



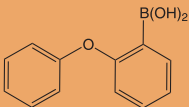
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48,345-1
C₁₂H₁₁BO₂



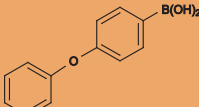
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25g

52,148-5
C₁₂H₁₁BO₃



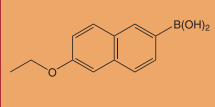
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48,014-2
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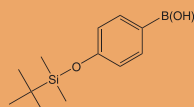
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52,190-6
C₁₂H₁₃BO₃



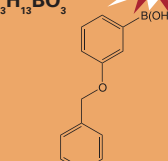
5g

52,404-2
C₁₂H₂₁BO₃Si



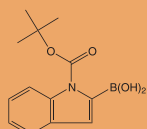
1g
5g

52,633-9
C₁₃H₁₃BO₃



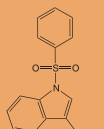
5g
25g

56,233-5
C₁₃H₁₆BNO₄



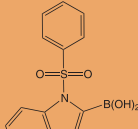
1g

56,387-0
C₁₄H₁₂BNO₄S



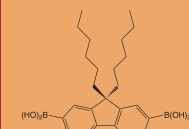
1g

56,386-2
C₁₄H₁₂BNO₄S



1g

56,633-0
C₂₅H₃₆B₂O₄



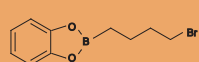
1g
5g

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Boronic Acid Esters

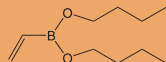
The synthesis of biaryl compounds via the Suzuki coupling reaction has become more commonplace now that many arylboronic acids are readily available. Several years ago, Miyaura et al. demonstrated the utility of cyclic pinacol esters of arylboronic acids in Suzuki coupling reactions.^{2,3} Aldrich is pleased to offer the following arylboronic acid pinacol esters as part of a growing line of reagents used in the Suzuki coupling reaction.

51,368-7
C₁₀H₁₂BBrO₂



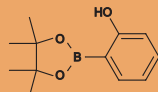
50g

56,814-7
C₁₀H₂₁BO₂



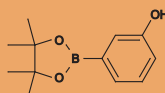
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5g

52,255-4
C₁₂H₁₇BO₃



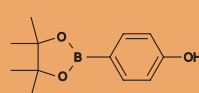
1g
5g

52,256-2
C₁₂H₁₇BO₃



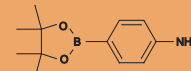
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5g

52,257-0
C₁₂H₁₇BO₃



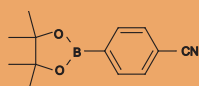
1g
5g

51,875-1
C₁₂H₁₈BNO₂



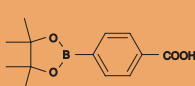
1g
5g

52,755-6
C₁₃H₁₆BNO₂



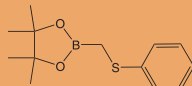
1g
5g

51,349-0
C₁₃H₁₇BO₄



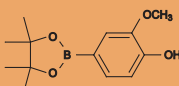
5g

56,815-5
C₁₃H₁₉BO₂S



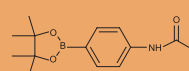
1g
5g

51,878-6
C₁₃H₁₉BO₄



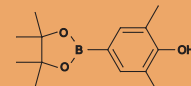
1g
5g

51,877-8
C₁₄H₂₀BNO₃



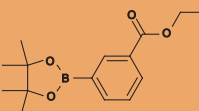
1g
5g

51,879-4
C₁₄H₂₁BO₃



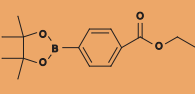
1g
5g

52,754-8
C₁₅H₂₁BO₄



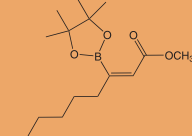
1g
5g

52,756-4
C₁₅H₂₁BO₄



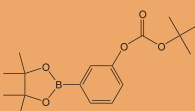
1g
5g

54,062-5
C₁₅H₂₇BO₄



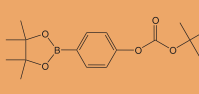
1g

56,582-2
C₁₇H₂₅BO₅



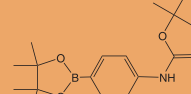
1g
5g

56,594-6
C₁₇H₂₅BO₅



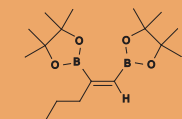
1g
5g

56,235-1
C₁₇H₂₈BNO₄



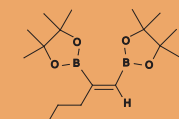
1g
5g

52,990-7
C₁₇H₃₂B₂O₄



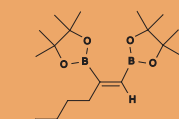
1g
5g

52,760-2
C₁₈H₃₄B₂O₄



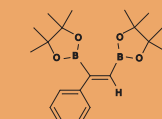
1g
5g

52,989-3
C₁₉H₃₆B₂O₄



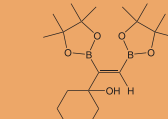
1g
5g

52,757-2
C₂₀H₃₀B₂O₄



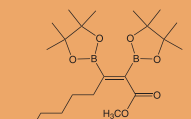
1g
5g

52,761-0
C₂₀H₃₆B₂O₅



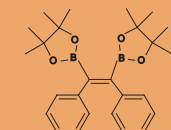
1g
5g

52,759-9
C₂₁H₃₈B₂O₆



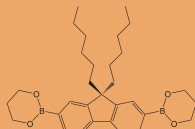
1g
5g

52,758-0
C₂₆H₃₄B₂O₄



1g
5g

56,668-3
C₃₁H₄₄B₂O₄



1g
5g

References

- (1) Miyaura, N. et al. *Synth. Commun.* **1981**, *11*, 513.
- (2) Ishiyama, T. et al. *Tetrahedron Lett.* **1997**, *38*, 3447.
- (3) Ishiyama, T. et al. *J. Org. Chem.* **1995**, *60*, 7508.
- (4) Pietrre, S.R.; Baltzer, S. *Tetrahedron Lett.* **1997**, *38*, 1197.
- (5) Brown, S.D.; Armstrong, R.W. *J. Am. Chem. Soc.* **1996**, *118*, 6331.
- (6) Suzuki, A. *J. Organomet. Chem.* **1999**, *576*, 147.
- (7) Stanforth, S. *Tetrahedron* **1998**, *54*, 263.
- (8) Miyaura, N.; Suzuki, A. *Chem. Rev.* **1995**, *95*, 2457.

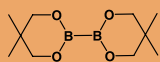
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Diboron Esters

The following diboron esters are versatile reagents that couple with organic triflates² and halides³ to give the corresponding boronic esters, which are readily converted to arylboronic acids. This route and the subsequent Suzuki coupling reaction can be run under mild conditions, thus permitting the use of cyano-, ester-, carbonyl-, and nitro-substituted aryl rings. The wide variety of arylboronic acids available via these diboron esters also makes this class of compounds suitable for solid-phase combinatorial studies.^{4,5}

51,880-8

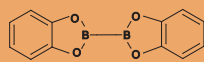
$C_{10}H_{20}B_2O_4$



1g
5g

47,328-6

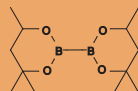
$C_{12}H_8B_2O_4$



1g
5g

52,568-5

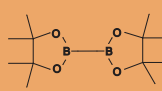
$C_{12}H_{24}B_2O_4$



1g
5g

47,329-4

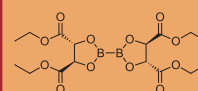
$C_{12}H_{24}B_2O_4$



1g
5g

52,716-5

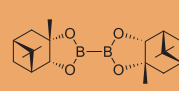
$C_{16}H_{24}B_2O_{12}$



1g
5g

52,714-9

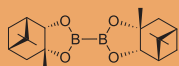
$C_{20}H_{32}B_2O_4$



1g
5g

52,713-0

$C_{20}H_{32}B_2O_4$



1g
5g

For references see Boronic Acid Esters section.



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Professor Akira Suzuki received his Ph.D. degree (1959) from Hokkaido University, Sapporo, Japan, where he later became a professor in the Department of Applied Chemistry (1973–94). In 1963–65, Dr. Suzuki worked as a postdoctoral associate in Professor Herbert C. Brown's research group investigating the stereochemistry of the hydroboration reaction. He was a visiting professor at several universities, including the University of Wales in 1988 and Purdue University in 2001. After his retirement from Hokkaido University in 1994, Professor Suzuki became a professor of chemistry at Okayama University of Science and was later appointed Professor at Kurashiki University of Science and the Arts in 1995. He has received numerous awards, including: Testimonial from the Korean Chemical Society (1987), the Chemical Society of Japan Award (1989), the H. C. Brown Lecturer Award (Purdue University, 2000), the 2001 Distinguished Lecturer Award (Queen's University, Canada, and Pfizer), and was made an Honorary Member of the Argentine Organic Chemistry Society in 2001.

Professor Suzuki's contributions to organoborane chemistry involve the discovery and development of new synthetic methodologies using organoboron compounds. The formation of organic radicals from organoboranes in the presence of catalytic amounts of oxygen was first discovered in the course of cooperative work with Professor Brown's research group. Professor Suzuki was also instrumental in the utilization of organoboron compounds as carbanions in synthesis. Organoboranes are also useful as a source of carbocations under electrochemical conditions, although a limited number of examples have been reported. More recent work by Suzuki and coworkers revolves around palladium catalyzed cross-coupling reactions of various organoboron compounds with a number of organic electrophiles in the presence of bases. This reaction has become known as the Suzuki Coupling and is the focus of this book.

Cyclic Aryl-Substituted Amino Acid Derivatives

Aryl α -substituted proline analogs and γ -substituted pyrrolidines are valuable building blocks in both medicinal and peptide chemistry. Through Suzuki coupling technology, they can be used as starting materials in the conversion of aryl bromides into biaryl compounds. These products have also found uses in peptide chemistry for the introduction of diversity and structural constraints in peptidomimetics.

58147	Boc- α -allyl-DL-proline	500mg	95566	Boc- α -propyl-DL-proline	500mg
52969	Boc- α -benzyl-DL-proline	500mg	92392	(4R)-Boc-4-benzyl-L-pyrrolidinic acid	500mg
90682	Boc- α -(2-bromobenzyl)-DL-proline	500mg	51747	(4R)-Boc-4-benzyl-L-pyrrolidinic acid benzyl ester	500mg
94866	Boc- α -(4-bromobenzyl)-DL-proline	500mg	74624	(4R)-Boc-4-(2-bromobenzyl)-L-pyrrolidinic acid benzyl ester	500mg
90683	Boc- α -(2-chlorobenzyl)-DL-proline	500mg	53371	(4R)-Boc-4-(4-bromobenzyl)-L-pyrrolidinic acid benzyl ester	500mg
90684	Boc- α -(3-chlorobenzyl)-DL-proline	500mg	59703	(4R)-Boc-4-(4-methylbenzyl)-L-pyrrolidinic acid benzyl ester	500mg
30763	Boc- α -(diphenylmethyl)-DL-proline	500mg			
74082	Boc- α -(4-fluorobenzyl)-DL-proline	500mg			
68691	Boc- α -methyl-DL-proline	500mg			
76501	Boc- α -(4-methylbenzyl)-DL-proline	500mg			
36748	Boc- α -(1-naphthylmethyl)-DL-proline	500mg			

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Transition-Metal Catalysts

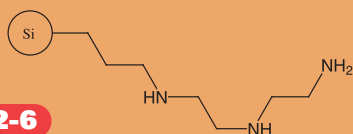
A variety of transition-metal catalysts for the Suzuki coupling reaction are available from Aldrich. The majority of these catalysts are palladium- and nickel-based, typically utilizing phosphine-derived ligands.⁶⁻⁸

47,055-4	[1,1'-Bis(diphenylphosphino)ferrocene]dichloronickel(II), 97%	1g
37,967-0	[1,1'-Bis(diphenylphosphino)ferrocene]dichloropalladium(II), complex with CH ₂ Cl ₂	1g; 5g
40,323-7	Dichlorobis(tricyclohexylphosphine)palladium(II), 95%	1g
45,304-8	Dichlorobis(tri- <i>o</i> -tolylphosphine)palladium(II), 97%	1g; 5g
20,867-1	Dichlorobis(triphenylphosphine)palladium(II), 98%	1g; 5g; 25g
41,274-0	Dichlorobis(triphenylphosphine)palladium(II), 99.99%	250mg; 1g
20,586-9	Palladium(II) acetate, 98%	1g; 2g; 10g
37,987-5	Palladium(II) acetate, 99.98%	1g; 5g
21,666-6	Tetrakis(triphenylphosphine)palladium(0), 99%	1g; 5g; 25g
32,877-4	Tris(dibenzylideneacetone)dipalladium(0)	500mg; 5g; 50g
36,631-5	Tris(dibenzylideneacetone)dipalladium(0)-chloroform adduct	250mg; 1g

For references see *Boronic Acid Esters* section.

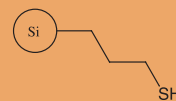
Palladium Scavengers

Scavenger resins have been commercially available for several years. Most of these scavengers have been used to sequester organic functionalities from solution in order to ease the purification process upon completion of the synthesis. Now, Aldrich is introducing a new class of quenching reagents: **palladium scavengers on silica gel**.



53,792-6

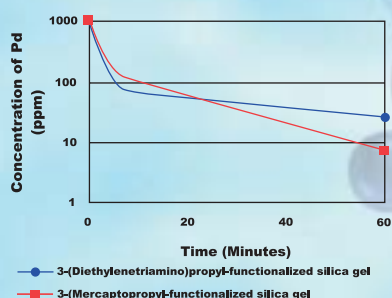
3-(Diethylenetriamino)propyl-functionalized silica gel
5g 25g 100g



53,808-6

3-Mercaptopropyl-functionalized silica gel
5g 25g 100g

Scavenging of Palladium



Conditions:

In separate flasks, two solutions of Pd(OAc)₂ (1000 ppm Pd) were prepared in THF. While stirring at room temperature, four equivalents of each of the silica-based scavengers were added to their respective flasks. As illustrated in the graph, the palladium was successfully scavenged from the solution within minutes. Simple filtration of the bound palladium allows for its recovery.

For the advantages of functionalized silica gels over polystyrene supports, please visit our Web site at www.sigma-aldrich.com/combichem and click on Solution-Phase Resins.

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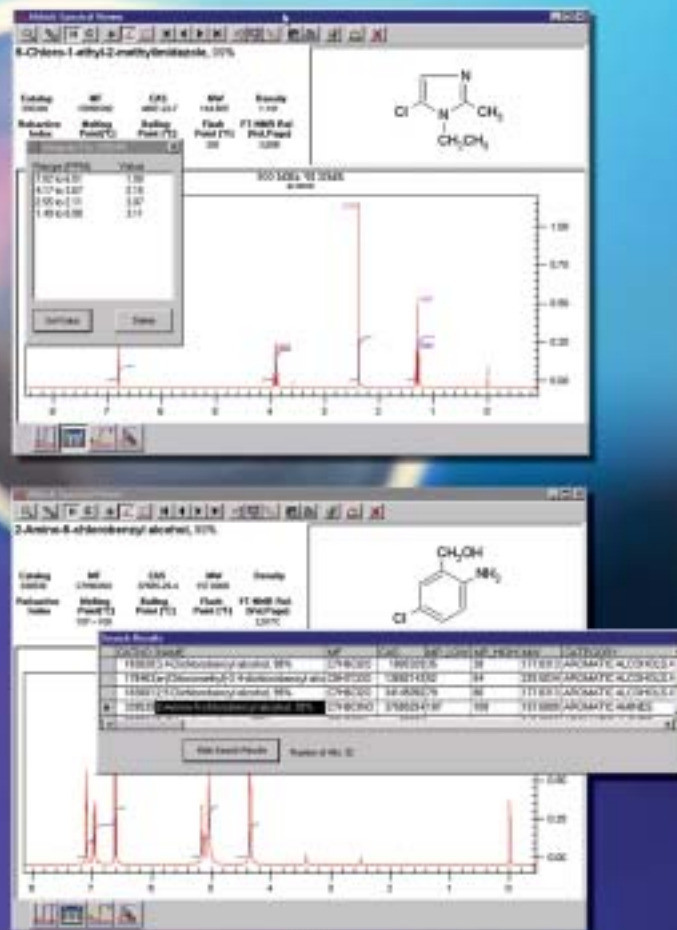
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Minimum system requirements: Pentium® 200MHz, Windows® 95/98/ME/NT4-SP5/2000, CD-ROM drive, 600MB hard disk space, 64MB RAM. (PC ONLY)

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Single user, academic	Z54,138-9	Z53,818-3
Network version (1-10 users)	Z54,149-4	Z53,797-7
Demo program	Z54,159-1	—

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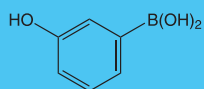
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Suzuki Coupling in Large Scale at Sigma-Aldrich Fine Chemicals

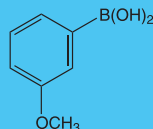
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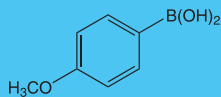
Examples of products available for large-scale Suzuki coupling:



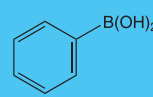
52,396-8 [87199-18-6]
3-Hydroxyphenylboronic acid
 500kg to MT MDL# 1074603



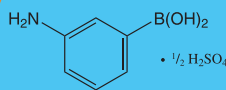
44,168-6 [10365-98-7]
3-Methoxyphenylboronic acid
 250-500kg MDL# 161359



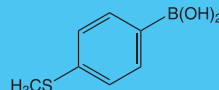
41,759-9 [5720-07-0]
4-Methoxyphenylboronic acid
 250-500kg MDL# 39139



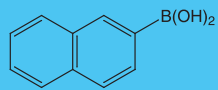
P2000-9 [98-80-6]
Phenylboronic acid, 97%
 250kg MDL# 2013



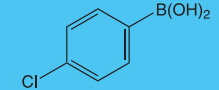
A7,175-1 [66472-86-4]
3-Aminophenylboronic acid hemisulfate
 50-100kg MDL# 13111



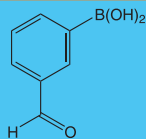
45,680-2 [98546-51-1]
4-(Methylthio)phenylboronic acid
 25-50kg MDL# 93410



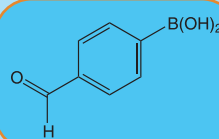
48,013-4 [32316-92-0]
2-Naphthaleneboronic acid
 25-50kg MDL# 236051



41,754-8 [1679-18-1]
4-Chlorophenylboronic acid
 25-50kg MDL# 39137



44,165-1 [87199-16-4]
3-Formylphenylboronic acid
 25kg MDL# 161356



43,196-6 [87199-17-5]
4-Formylphenylboronic acid
 25kg MDL# 151823



32,877-4 [52409-22-0]
Tris(dibenzylideneacetone)dipalladium(0)
 kg quantities MDL# 13310



21,666-6 [14221-01-3]
Tetrakis(triphenylphosphine)Pd(0)
 kg quantities MDL# 10012

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Handbook of Organopalladium Chemistry for Organic Synthesis

Ei-ichi Negishi, John Wiley & Sons, New York, NY, 2002, 1,392pp. Hardcover.
This handbook is the most comprehensive and authoritative reference available on organopalladium reagents and catalysts. The material is organized according to reaction type, rather than type of organopalladium compound.

Z51,386-5

Organoboranes for Syntheses

P.V. Ramachandran and H.C. Brown, Eds., Oxford University Press, New York, NY, 2001, 264pp. Hardcover.

This book examines the recent advances in the art of organic synthesis via organoboranes. The volume includes a wide range of topics in asymmetric synthesis, such as reduction, aldol reaction, allylboration, homologation, and cyclopropanation. Additional subjects include Suzuki coupling, amino acid synthesis, fluoro-organic synthesis, boron catalysts for stereoselective transformations, heterocyclic synthesis, and novel borohydride reagents.

Z51,374-1

Contemporary Boron Chemistry

M. Davidson et al., Eds., The Royal Society of Chemistry, Cambridge, UK, 2000, 538pp. Hardcover.

Covers boron chemistry with applications in polyolefin catalysis; medicine; materials and polymers; boron cluster chemistry, including carboranes and metal-containing clusters; organic and inorganic chemistry of species containing 1 or 2 boron atoms; and theoretical studies of boron-containing compounds. New materials with novel optical and electronic properties are also discussed.

Z52,633-9

Handbook of Palladium-Catalyzed Organic Reactions

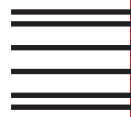
J.-L. Malleron, J.-C. Fiaud, and J.-Y. Legros, Academic Press, San Diego, CA, 1997, 304pp. Comb-bound.

Detailed descriptions of the main types of reactions that are catalyzed by palladium. Includes the catalytic cycles and mechanisms for each class of reactions.

Book Z28,778-4

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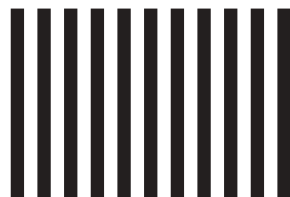
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*13th ed., Merck & Co.,
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