Synthesis E. Salomó et al. Special Topic

# Efficient Preparation of (*S*)- and (*R*)-*tert*-Butylmethylphosphine–Borane: A Novel Entry to Important P-Stereogenic Ligands

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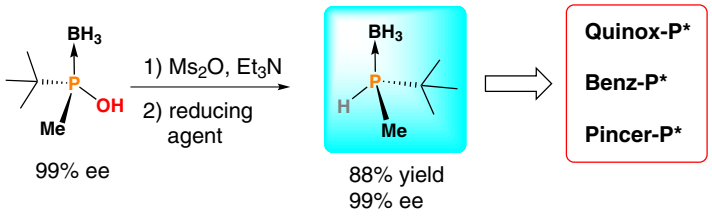


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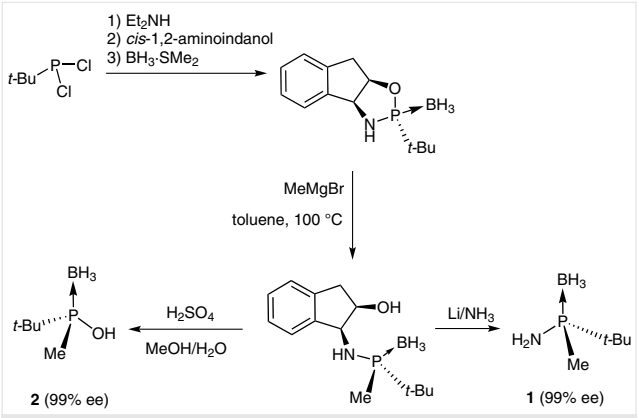
**Abstract** A novel one-pot reductive methodology for the synthesis of optically pure *tert*-butylmethylphosphine–borane is reported. The preparation uses as the starting material *tert*-butylmethylphosphinous acid–borane, which is available in both enantiomeric forms from *cis*-1,2-aminoindanol and *tert*-butyldichlorophosphine. The process is based on the reduction of a mixed anhydride, the configurational stability of which has been studied in several solvents and temperatures. Tetrabutylammonium borohydride was the best reducing agent allowing for the development of a practical process. To demonstrate the utility of the new methodology, the product obtained in this manner was used in the preparation of Quinox-P*.

**Key words** phosphorus, P-ligands, P-stereogenic phosphines, stereospecific reductions, ligand synthesis

P-Stereogenic phosphines are a subclass of phosphine ligands that have recently grown into one of the most efficient type of ligands for asymmetric hydrogenation and other relevant industrial processes.[1] In this respect, the development of synthetic methodology allowing for the efficient synthesis of such compounds is of crucial importance. In our group, we have developed a novel strategy for the synthesis of valuable P-stereogenic synthons like amino(*tert*-butyl)methylphosphine–borane **1** and *tert*-butylmethylphosphinous acid–borane **2** (Scheme 1).[2] Compounds **1** and **2** have been employed in the synthesis of MaxPHOS, SIP, and phosphinooxazoline ligands that have proven very efficient in asymmetric hydrogenation and [2+2+2]-cycloaddition reactions.[2a,e,f] Compounds **1** and **2** are valuable because they bear in common the *tert*-butylmethylphosphine moiety which provides a high steric bias when the phosphorus is coordinated to the metal center.




**Scheme 1** Synthesis of optically pure P-stereogenic synthons

Another important P-stereogenic building-block of the same family is the *tert*-butylmethylphosphine–borane **3**, that has been used by Imamoto for the synthesis of $C_2$ symmetric Quinox-P*, Benz-P*, and Pincer-P* ligands (Figure 1).[3] These ligands have been demonstrated to be very efficient in numerous catalytic processes.[4] The synthesis reported for **3** relies on the stereoselective deprotonation of *tert*-butyldimethylphosphine–borane with the sparteine/*s*-BuLi couple, followed by oxidation of the corresponding phosphide with $O_2$ to yield the corresponding (hy-

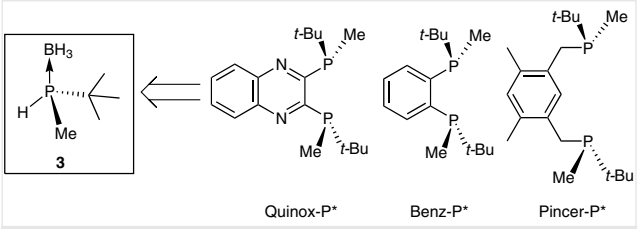



**Figure 1** *tert*-Butylmethylphosphine–borane **3** serves as a precursor for important P-stereogenic $C_2$-bisphosphines