SYNLETT Spotlight 315

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

Triphenylphosphine Dibromide

Compiled by Garima

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Dedicated to my honarable mentor Prof. L. D. S. Yadav



Introduction

Triphenylphosphine dibromide (TPPDB, PPh₃Br₂), originally synthesized by Horner and his co-workers, has shown significant synthetic versatility over the course of the last decades in organic synthesis. It has been used extensively in various organic transformations, such as bromination of alcohols, phenols, and enols, cleavage of ethers and acetals to alkyl bromides, cyclization of β - and γ -amino alcohols to aziridines and azetidines, conversion of carboxylic acid derivatives into acyl bromides, bromination or dehydration of carboxamide groups and epoxide opening to vicinal dibromides. Some of these resulting compounds have been reused in total syntheses of complex natural products during the final steps. Thus, the chemoselectivity and predictable reactivity of triphenylphosphine dibromide makes it a noteworthy and useful

reagent. It also finds application in the synthesis of ¹⁸F-4-fluorobenzyltriphenylphosphonium bromide, a new class of positron-emitting lipophilic cations, acting as myocardial per fusion PET tracers.³

Triphenylphosphine dibromide is a colorless crystalline hygroscopic solid (mp 235 °C) that is readily prepared before use by addition of an equimolar amount of bromine to triphenylphosphine in anhydrous diethyl ether at 0 °C (Scheme 1).⁴ It is a molecular compound in the solid state, but ionises in dichloromethane to form [Ph₃PBr]+Br^{-.5}

$$Ph_3P + Br_2 \xrightarrow{Et_2O} Ph \\ Ph' Ph \\ Br \\ TPPDB$$

Scheme 1

Abstract

(A) Preparation of Alkyl, Allyl, and Aryl Bromides:

Horner and co-workers¹ demonstrated the application of triphenylphosphine dibromide for the conversion of alcohols and phenols into bromides. It has advantages over the other phosphorus-based reagents in effecting substitution without elimination or molecular rearrangement with inversion of the product configuration. It becomes the reagent of choice for the conversion of various types of alcohol-containing sensitive functionalities, such as *cis* double bonds and ketals, into the corresponding bromides.⁶

(B) Ring Opening of Aziridines:

Kumar and co-workers 7 have reported the use of PPh_3Br_2 as highly efficient reagent for the ring opening of aziridines affording β -bromo amines. The method works effectively for both activated and non-activated aziridines in excellent yields within a short period of time.

$$R^2$$
 N-R¹ , PPh₃Br₂ MeCN, r.t. R^2 NHR

 R^3 Br

 R^3 Br

 R^3 Br

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(C) Synthesis of Vinyl Bromides:

Kamei and co-workers⁸ have developed a new synthetic method for the preparation of vinyl bromides from acyclic and cyclic ketones.

(D) Conversion of TBDMS and THP Ethers into Bromides:

 PPh_3Br_2 is a mild and highly effective reagent for the direct cleavage of TBDMS and THP ethers into bromides.⁹

(E) Preparation of Esters:

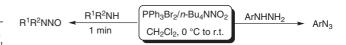
Salomé and Kohn¹⁰ have reported a one-pot, expedient protocol for the conversion of carboxylic acids into their esters using excess triphenylphosphine dibromide, base, and alcohol. The reaction gave the esterified product in moderate to high yields.

R¹ = Alk, Ar, Hetai

R² = Alk (primary, secondary, or tertiary), allyl

(F) Preparation of N-Nitrosamines and Azides:

The PPh₃Br₂ in combination with *n*-Bu₄NNO₂ has been applied successfully for the preparation of *N*-nitrosamines and azides from the corresponding amines and hydrazine derivatives in excellent yields.¹¹



R¹, R² = Alk, cycloalkyl, Bn, heterocycloalkyl

(G) Oxidation of Alcohols:

The use of PPh₃Br₂ in combination with DMSO is found to be a good alternative to the classical Swern oxidation. A variety of alcohols has been oxidized under mild conditions by the DMSO-PPh₃Br₂ complexes.¹²

OH

$$R^1$$
 + PPh₃Br₂ + DMSO + Et₃N $\xrightarrow{CH_2Cl_2, \\ -78 \text{ °C}, 2 \text{ h}}$ R^1

(H) Nitration of Aromatic Amines:

The use of PPh₃Br₂/AgNO₃ provides a new reagent system for the novel and highly chemoselective nitration of aromatic amines under mild reaction conditions.¹³

ArH
$$\frac{\text{Ph}_3\text{P, Br}_2, \text{AgNO}_3}{\text{MeCN, r.t., 5 min}}$$
 ArNO₂

ArH = aromatic amines

(I) Deoxygenation of Sulfoxides:

The combination of $Ph_3P/Br_2/CuBr$ was found to be an effective promoter for the deoxygenation of sulfoxides and afforded the corresponding sulfides in excellent yields.¹⁴

$$\begin{array}{ccc}
O \\
| | | \\
R^{1} & \\
\end{array}$$

$$\begin{array}{ccc}
Ph_{3}P, Br_{2}, CuBr \\
\hline
MeCN, reflux
\end{array}$$

$$R^{1} & \\
\end{array}$$

$$R^{2}$$

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