

SYNLETT Spotlight 102

Cesium Carbonate (Cs₂CO₃)

Compiled by Fredrik Lehmann



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

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Introduction

Cesium carbonate is a white hygroscopic powder that is readily soluble in water. It is produced by reacting cesium hydroxide with carbon dioxide¹ (Scheme 1).



Scheme 1 Preparation of cesium carbonate.

Many of the properties of cesium carbonate are due to the softness of the cesium cation. This softness makes cesium carbonate rather soluble in organic solvents such as alcohols, DMF and Et₂O. This has rendered cesium carbonate useful in palladium chemistry, which is often carried out in non-aqueous media where insolubility of inorganic bases can limit reactivity. Cs₂CO₃ has, for example, been used with good results in Heck,^{2,3} Suzuki⁴ and Sonogashira⁵ reactions.

Cesium carbonate has also received much attention for its use in O-alkylations, particularly of phenols.^{6,7} It has been

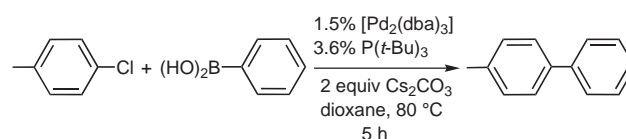
postulated that O-alkylations of phenols using Cs₂CO₃ in non-aqueous solvents occurs via the 'naked' phenolate anion, which behaves as a strong nucleophile. Therefore, this methodology can even be applied to secondary halides, minimizing the usual unwanted side reactions such as elimination and decomposition.

Cesium carbonate has also found much use in solid supported synthesis, where solubility can be of importance. It has been reported that it not only promotes successful carbonylation of alcohols and carbamination of amines, but also suppresses common side reactions traditionally encountered with other protocols.⁸

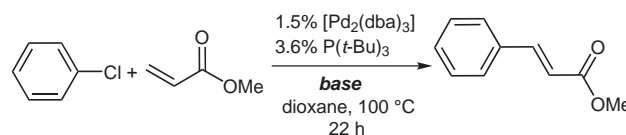
In peptide chemistry, a very mild way to produce esters of amino-protected peptides is to treat the carboxylic acid with cesium carbonate followed by the addition of a halide in DMF.⁹ An intramolecular version has been used to produce macrocyclic lactones.¹⁰

Abstracts

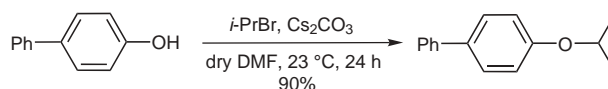
(A) Fu and co-workers have used Cs₂CO₃ as the base in Suzuki cross-coupling reactions with yields up to 86%. When the same reactions were performed with Na₂CO₃ or NEt₃, the yields were 29% and 50%, respectively.⁴



(B) Littke and Fu have also shown the superiority of Cs₂CO₃ as compared with other bases in the Heck coupling of methylacrylate with chlorobenzene. K₂CO₃, NaOAc, NEt₃, K₃PO₄ and Cs₂CO₃ were used to provide yields of only 9%, 21%, 37%, 50% and 56%, respectively.²



(C) In the alkylation of phenols, Parrish and coworkers have shown the utility of Cs₂CO₃. Its use makes the alkylation possible even with highly reactive halides which, under other conditions, are prone to eliminations or other side reactions.⁶



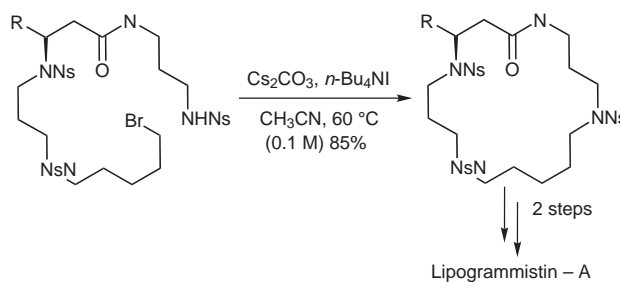
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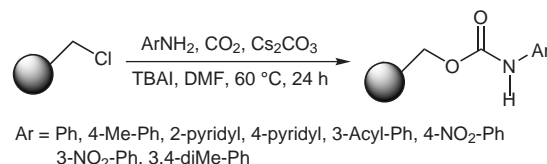
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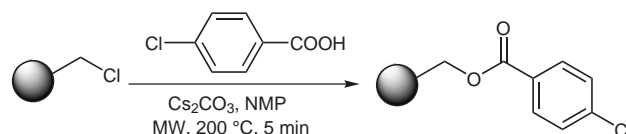
(D) In natural product chemistry, Fujivara et al. have used Cs_2CO_3 in the key ring-forming step in the synthesis of lipogrammistin-A, originally isolated from the skin mucus of the grammistid fish.¹¹



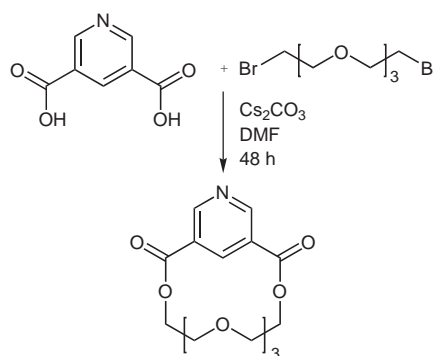
(E) Salvatore et al. used Cs_2CO_3 when constructing carbonates (not shown) and carbamates in good yield on solid support under CO_2 atmosphere and with TBAI as a co-catalyst.⁸



(F) Walla and Kappe have shown the utility of Cs_2CO_3 as a base when connecting benzoic acids to Merrifield resins under microwave irradiation.¹²



(G) Large macrocycles can be prepared using Cs_2CO_3 . The reagent serves both as a base and as a cation template in the macrocyclization of dicarboxylic acids and dihalides to generate the desired crown ethers.¹⁰



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