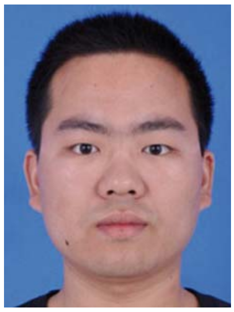
SYNLETT
Spotlight 392

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

Titanium(III) Trichloride

Compiled by Pei-He Li



Pei-He Li was born in Handan, P. R. of China. He received his B.Sc. in 2011 from the Hebei Normal University, P. R. of China. Currently he is working towards his M.Sc degree under the supervision of Professor Zhan-Hui Zhang at the same university. His research interests focus on the development of new reagents and catalysts in organic synthesis.

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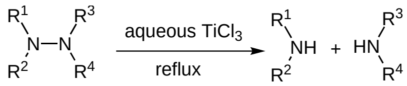
Introduction

Titanium(III) chloride is red-violet crystalline solid soluble in water and alcohol. It has been extensively used as a mild and useful reagent with diverse applications in organic synthesis, such as reduction of aromatic aldehydes, glycosyl halides, vicinal dihalides, sulfoxides,[1] oximes,[2–5] hydroxamic acids,[6] nitro group,[7] and dehalogenation of α-halo ketones.[8] In addition, the aqueous $TiCl_3/NH_3$ system has been used to promote the reduction of aromatic aldehydes, ketenes, and diketones to give alcohols.[9,10] Reductive cyclizations of oxoamides to produce indoles can also be effectively promoted by $TiCl_3$.[11] Apart from these applications, $TiCl_3$ is also known as a Lewis acid to catalyze the $SnCl_2$-mediated Barbier reactions between aldehydes and allyl halides in aqueous media.[12]

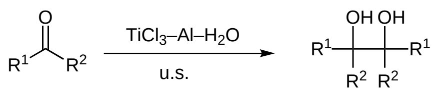
$TiCl_3$ is commercially available and can be synthesized by dissolving titanium in aqueous hydrochloric acid.

Abstracts

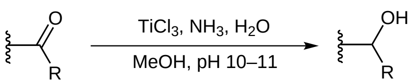
(A) *Reduction of Hydrazines to Amines*:
Zhang and co-workers have developed a new and efficient method for the reductive cleavage of N–N bonds in hydrazines to afford amines using an aqueous solution of $TiCl_3$ as reducing agent. The reactions proceed smoothly under abroad pH range from acidic, neutral to basic. Furthermore, the reaction conditions displayed a high tolerance for the substrates containing functionalities, such as C=C double bonds, benzyl–nitrogen bonds, benzyloxy and acyl groups.[13]



(B) *Reductive Coupling of Aromatic Aldehydes or Ketones to Pinacol*:
Lin and co-workers found that titanium trichloride in H_2O can be reduced by Al to the corresponding low valent titanium, which can reduce coupling of aromatic aldehydes and ketones to the corresponding pinacols at room temperature under ultrasound irradiation.[14] The reductive coupling of aromatic aldehydes can also be carried out in the $Al–TiCl_3–CH_2Cl_2$ system under microwave irradiation.[15]



(C) *Reduction of Aromatic Aldehydes, Ketenes, and Diketones to Alcohols*:
Aqueous $TiCl_3/NH_3$ system can be applied for the reduction of aromatic aldehydes, ketones, diketones and oxo aldehydes to the corresponding alcohols. The protocol is tolerant to a number of functional groups, such as acids, esters, amides and cyano, bromo, chloro, methoxy, dimethyl acetal and α-cyclopropyl groups.[16]



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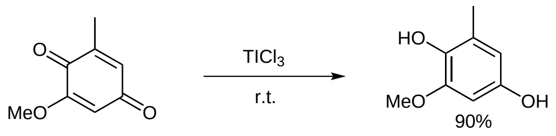
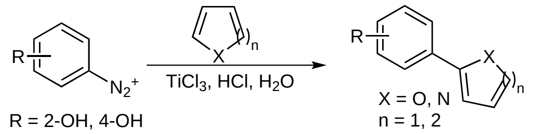
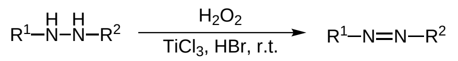
(D) *Reductive of Quinone to Hydroquinone*:
Lee and co-workers found that 2-methoxy-6-methyl-[1,4]benzoquinone can be reduced to 2-methoxy-6-methylbenzene-1,4-diol using $TiCl_3$ with high yield.[17]



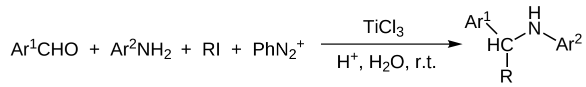
(E) *Arylations of Heterocycles*:
Pratsch et al. reported that titanium-mediated arylations led to the formation of C–C bonds by radical reactions of hydroxy phenyldiazoniumion ions and a highly reactive arylradical scavenger, such as furan and pyridine.[18]



(F) *Catalytic Oxidation of Hydrazo Derivatives*:
A novel method for the selective oxidation of hydrazo compounds into the corresponding azo compounds using the $TiCl_3$/HBr system has been developed.[19]



(G) *Alkyl Radical Additions to Imines*:
Cannella et al. reported that the aqueous $TiCl_3/PhN_2^+$ system can promote arylative amination of aldehydes in a one-pot, three-component reaction. In this process, $TiCl_3$ acts as both radical initiator and terminator in its lower oxidation state and as a Lewis acid to promote imine formation and activation in its higher oxidation state.[20]



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