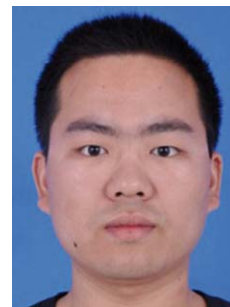


SYNLETT Spotlight 392

Titanium(III) Trichloride

Compiled by Pei-He Li



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

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 $\text{TiCl}_3/\text{NH}_3$ system has been used to promote the reduction of aromatic alde-

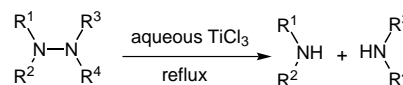
hydes, ketenes, and diketones to give alcohols.^{9,10} Reductive cyclizations of oxoamides to produce indoles can also be effectively promoted by TiCl_3 .¹¹ Apart from these applications, TiCl_3 is also known as a Lewis acid to catalyze the SnCl_2 -mediated Barbier reactions between aldehydes and allyl halides in aqueous media.¹²

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

Abstracts

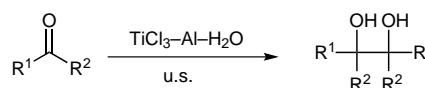
(A) Reduction of Hydrazines to Amines:

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 a broad 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



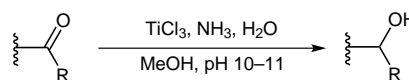
(B) Reductive Coupling of Aromatic Aldehydes or Ketones to Pinacol:

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 $\text{Al-TiCl}_3\text{-CH}_2\text{Cl}_2$ system under microwave irradiation.¹⁵



(C) Reduction of Aromatic Aldehydes, Ketenes, and Diketones to Alcohols:

Aqueous $\text{TiCl}_3/\text{NH}_3$ 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



SYNLETT 2012, 23, 1264–1265

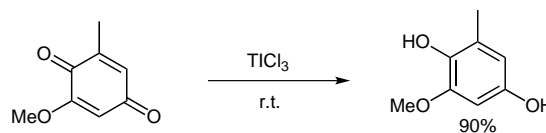
Advanced online publication: 26.04.2012

DOI: 10.1055/s-0031-1291016; Art ID: ST-2012-V0399-V

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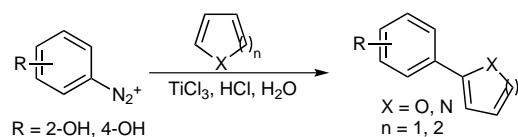
(D) Reductive of Quinone to Hydroquinone:

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



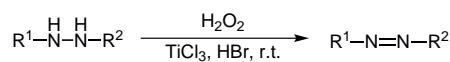
(E) Arylations of Heterocycles:

Pratsch et al. reported that titanium-mediated arylations led to the formation of C–C bonds by radical reactions of hydroxy phenyldiazonium ions and a highly reactive arylradical scavenger, such as furan and pyridine.¹⁸



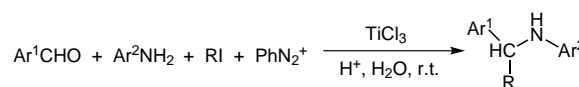
(F) Catalytic Oxidation of Hydrazo Derivatives:

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 $\text{TiCl}_3/\text{PhN}_2^+$ 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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