

Reducing Characteristics of Metal Diisobutyl-*t*-butoxyaluminum Hydrides for Tertiary Amides

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A simple and useful partial reduction of tertiary amides into aldehydes is one of the highly desirable means in organic synthesis, and hence some useful reducing agents for this have been reported.¹ Recently, we have reported that a new class of reducing agents, metal diisobutyl-*t*-butoxyaluminum hydrides such as lithium diisobutyl-*t*-butoxyaluminum hydride (LDBBA),^{2a} sodium diisobutyl-*t*-butoxyaluminum hydride (SDBBA),^{2b} and potassium diisobutyl-*t*-butoxyaluminum hydride (PDBBA),^{2c} are new effective partial reducing agents which can reduce various esters to aldehydes in high yields. Among them, LDBBA was especially effective for partial reduction of isopropyl esters to aldehydes usually in higher than 90% at 0 °C. Also, SDBBA and PDBBA were effective for partial reduction of common methyl and ethyl esters in high yield (71-93%) at 0 °C.

With these results in hand, we anticipated that metal diisobutyl-*t*-butoxyaluminum hydrides (LDBBA, SDBBA and PDBBA) would also be effective in developing an efficient method for partial reduction of tertiary amides. Herein, we wish to report the results of our study for partial reduction of tertiary amides to aldehydes (Scheme 1).

Results and Discussion

The common metal (Li, Na, K) diisobutyl-*t*-butoxyaluminum hydrides can be readily prepared by a simple reaction of DIBAH with the corresponding metal *t*-butoxides in THF at 0 °C or room temperature.²

We first examined the partial reduction of *N,N*-dimethylbenzamide as a representative with LDBBA, SDBBA, and PDBBA in THF at room temperature to find out an optimum reaction conditions. The results are summarized in Table 1.

As shown in Table 1, the LDBBA was more readily reduced the *N,N*-dimethylbenzamide to benzaldehyde than

Table 1. Reduction of *N,N*-dimethylbenzamide with metal diisobutyl-*t*-butoxyaluminum hydrides at room temperature

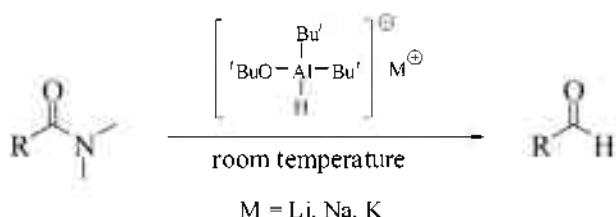
Compound	Hydride	Reaction condition		Yield of aldehyde (%) ^a	
		H ⁻	time (h)		
<i>N,N</i> -dimethylbenzamide	LDBBA	1.2	3	52	
			12	89	
		1.5	24	58	
			1	82	
			3	84	
			24	90	
	SDBBA	1.2	24	65	
			1.3	24	72
			1.5	3	42
		2.0	6	61	
			12	70	
			24	90	
PDBBA	1.5	5	trace		
		6	70		
		24	trace		

^aYields were determined by GC.

SDBBA at room temperature. Especially, the PDBBA almost did not react with *N,N*-dimethylbenzamide under the similar condition. The reactivity may be attributed to the electronic effect of the counter metal cations in the metal diisobutyl-*t*-butoxyaluminum hydrides. Using the best reaction condition from the experimental results, we applied these reducing agents for the synthesis of aldehydes from the various tertiary amides, respectively. The results for representative tertiary amides are summarized in Table 2.

As shown in Table 2, both LDBBA and SDBBA were good to convert tertiary amides to the corresponding aldehydes. Thus, various aromatic amides examined possessing electron-withdrawing or electron-donating groups are readily converted to the corresponding aldehydes. A simple aliphatic and heterocyclic amide is also readily reduced to aldehydes in high yields.

The utility of metal diisobutyl-*t*-butoxyaluminum hydrides (LDBBA, SDBBA and PDBBA) as a partial reducing agent for tertiary amides to aldehydes has been examined in this study. Among them, both LDBBA and SDBBA appeared to be an excellent reagent for partial reduction of tertiary



Scheme 1

Table 2. Yields of aldehydes in the partial reduction of representative tertiary amides with LDBBA, SDBBA and PDBBA at room temperature

Entry	Compound	Yield of aldehyde (%) ^a		
		LDBBA ^b	SDBBA ^c	PDBBA ^c
1	<i>N,N</i> -dimethylbenzamide	89	90	trace
2	<i>N,N</i> -dimethyl-4-chlorobenzamide	93	88	trace
3	<i>N,N</i> -dimethyl-4-chlorobenzamide	92	89	trace
4	<i>N,N</i> -dimethyl-3-chlorobenzamide	85	74	trace
5	<i>N,N</i> -dimethyl-3-toluamide	88	84	trace
6	<i>N,N</i> -dimethyl-4-methoxybenzamide	90	79	trace
7	<i>N,N</i> -dimethyl-4-naphthylamide	90	91	trace
8	<i>N,N</i> -dimethyl-4-furoamide	82	74	trace
9	<i>N,N</i> -dimethylcaproamide	87 ^d	81 ^e	trace

^aYields were determined by GC. ^bReacted for 12 h. reagent:compound = 1.2:1. ^cReacted for 24 h. reagent:compound = 1.5:1. ^dReacted for 24 h. reagent:compound = 1.2:1. ^eReacted for 24 h. reagent:compound = 3:1.

amides under the mild condition. Therefore, these reagents are should be useful as a reagent of choice for the synthesis of aldehydes from tertiary amides.

Experimental Section

General. All glassware used was dried thoroughly in an oven, assembled hot, and cooled under a stream of dry nitrogen prior to use. All reaction and manipulation of air and moisture sensitive materials were carried out using standard techniques for handling air sensitive materials. All chemicals except tertiary amides were commercial products of the highest pure which were purified further by standard methods before use. THF was dried over sodium-benzophenone and distilled. Diisobutylaluminum hydride (DIBALH), *n*-butyllithium, *t*-butyl alcohol, sodium *t*-butoxide and potassium *t*-butoxide were purchased from Aldrich Chemical Company. Tertiary amides were prepared by the method of Brown and Tsukamoto.^{1c} GC analyses were performed on a Donam DS 6200 FID chromatograph, using a HP-1 capillary column (30m). All GC yields were determined with use of a suitable internal standard and authentic mixture. The concentration of metal diisobutyl-*t*-butoxyaluminum hydrides solution in THF-hexane was measured gasometrically by hydrolysis of an aliquot of the solution with a hydrolyzing mixture of *t*-butyl alcohol-THF (1:1) at 0 °C.

Preparation of LDBBA. To a solution of *t*-butyl alcohol (5.16 mL, 55 mmol) in THF (25 mL) was added *n*-butyllithium (20 mL, 2.5 M in hexane, 55 mmol) at 0 °C. After being stirred for 1 h at room temperature, DIBALH (50 mL, 1.0 M in hexane, 50 mmol) was added dropwise to the reaction mixture at 0 °C and the mixture was stirred for 2 h at room temperature to give a colorless homogeneous solution.

Preparation of SDBBA and PDBBA. To a solution of sodium *t*-butoxide (5.05 g, 52.5 mmol) or potassium *t*-

butoxide (5.89 g, 52.5 mmol) in THF (50 mL), DIBALH (50 mL, 1.0 M in hexane, 50 mmol) was added dropwise at 0 °C and the mixture was stirred for 2 h at room temperature to give a colorless homogeneous solution.

Stability of new hydrides. The LDBBA, SDBBA and PDBBA solutions were stable in the refrigerator for 6 months without any appreciable loss of hydride content.

Reduction of tertiary amides to aldehydes. The following procedure for the reduction of *N,N*-dimethylbenzamide with LDBBA is representative. To a solution of *N,N*-dimethylbenzamide (0.075 g, 0.5 mmol) in THF (5 mL) containing naphthalene as an internal standard was added LDBBA (1.3 mL, 0.46 M in THF-hexane) at room temperature. After 12 h, the reaction mixture was hydrolyzed with 5 mL of 1 N HCl (aq) and the product was extracted with 10 mL of diethyl ether. The ether layer was dried over anhydrous magnesium sulfate. GC analysis showed an 89% yield of benzaldehyde.

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