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Lithium and Potassium Bis(trimethylsilyl)amide[1]: Utilizing Non-nucleophilic Bases as Nitrogen Sources

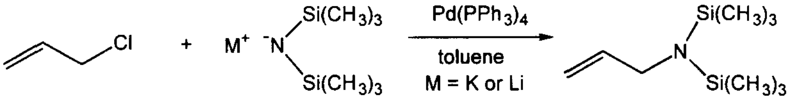
Jörg Brüning

Callery Chemical Company, Division of Mine Safety Appliances, 1420 Mars-Evans City Road, Evans City, PA 16033[*]

Abstract: *Lithium and potassium bis(trimethylsilyl)amides are successfully utilized as nitrogen sources in palladium(0) catalyzed aminations of allylchloride.* © 1997 Elsevier Science Ltd.

Since their discovery, lithium, sodium and potassium bis(trimethylsilyl)amides (LiHMDS, NaHMDS, KHMDS) have been used extensively as sterically hindered bases in organic synthesis.[2] However, they rarely have been exploited as a nitrogen source.[3] The reported alkylation reactions of alkali metal bis(trimethylsilyl)-amides usually require an alkylbromide, iodide or tosylate in order to achieve acceptable yields. An exception is the nearly quantitative amination of α–chloroboronic esters with LiHMDS.[4]

The amination of the less expensive alkylchlorides, from an economical point of view, is far more attractive, but hampered by the low reactivity of the alkylchlorides. To enhance the reactivity of substrates containing aryl- or propenylchloride substructures, transition metals have been employed as catalysts.[5] In an established method , palladium(0) is utilized to catalyze aminations with primary and secondary amines.[6] However, to the best of my knowledge, palladium(0) catalyzed aminations with alkali metal bis(trimethylsilyl)amide as a nitrogen source have not been reported.[7] This communication now describes the first successful examples of palladium catalyzed aminations of allylchloride with lithium and potassium bis(trimethylsilyl)amide.



Addition of a solution of LiHMDS (7.45 g, 44.3 mmol) in dry toluene (50 ml) to a slurry of $Pd(PPh_3)_4$ (1.0 g, 0.86 mmol, 2 mol%) and freshly distilled allylchloride (4.3 ml, 52 mmol, 1.2 eq) in dry, degassed toluene (14 ml) at room temperature gave the desired allyl bis(trimethylsilyl)amide (allylHMDS) in about 94% yield (by gas chromatography, GC). The reaction mixture was stirred for 2 h and then submitted to an aqueous workup (40 ml saturated NH_4Cl solution, 2 x 20 ml water) and drying (Na_2SO_4). Distillation afforded 4.8 g (53%) of allylHMDS (Bp. 84 °C/35 Torr).[8]

Further experimentation confirmed the beneficial impact of palladium(0) on the reaction yield, thus confirming its catalytic role (see Table). In addition, the reaction temperature and the mode of addition seemed to influence the outcome of the amination. A lower reaction temperature (0°C) led to decreased yields with potassium bis(trimethylsilyl)amide (compare runs 8 and 9). The inverse addition mode proved to be more efficient in aminations with KHMDS (compare runs 6 and 8). On a larger scale, the addition of a solution of allylchloride (9 ml, 110 mmol, 1.2 eq) in toluene (20 ml) to a slurry of KHMDS (22.07 g, 92 mmol) and

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[*] *e-mail: Joerg.Bruening@MSAnet.com*

$Pd(PPh_3)_4$ (2.29 g, 1.98 mmol, 2.15 mol%) in dry toluene (130 ml) resulted in 90% conversion (GC, 0.5h) and gave 10 g (55%) allylHMDS after aqueous workup and distillation.

Table:

Run	Base	Catalyst	Temperature	Addition mode	Yield[c] [%]
1	LiHMDS	none	r.t.	A[a]	<19
2	LiHMDS	$Pd(PPh_3)_4$	r.t.	A	85-94 (53)[d]
3	LiHMDS	none	r.t.	B[b]	<15
4	LiHMDS	$Pd(PPh_3)_4$	r.t.	B	69
5	KHMDS	none	r.t.	A	<10
6	KHMDS	$Pd(PPh_3)_4$	r.t.	A	60
7	KHMDS	none	r.t.	B	10
8	KHMDS	$Pd(PPh_3)_4$	r.t.	B	88 (55)[d]
9	KHMDS	$Pd(PPh_3)_4$	0°C	B	38

[a] Addition mode A: a solution of LiHMDS or KHMDS in toluene was slowly added to a slurry of freshly distilled allylchloride (1.2 eq) and $Pd(PPh_3)_4$ (2.0-2.2 mol%) in dry toluene. [b] Addition mode B: fresh distilled allylchloride (1.1 eq) was slowly added to a slurry of LiHMDS or KHMDS and $Pd(PPh_3)_4$ (2.0 -2.2 mol%) in dry toluene. [c] Yield determined by GC with an internal standard (1,2,4-trimethylbenzene, response factor TMB/allylHMDS $\approx$ 1.186). [d] Isolated yield, see also note 9.

In conclusion this report demonstrates that lithium and potassium bis(trimethylsilyl)amide can be utilized as nitrogen sources in palladium catalyzed aminations of allylchloride. The use of metal bis(trimethylsilyl)amides as nucleophiles is especially noteworthy considering that sodium bis(trimethylsilyl)-amide was used as a base in the synthesis of cyclopropene via deprotonation of allylchloride.[10] The described method provides an access to allylic primary amines and might be useful in the recently reported efforts of enantioselective allylic aminations with chiral palladium catalysts.[11] The presented results provide an example of how catalysts and suitable reaction conditions are able to expand the scope of commercially available reagents.

REFERENCES AND NOTES

1. Commercially available in bulk quantities from Callery Chemical Company.
2. Rathman, T.L. *Chem. Spec.* **1989**, *9(5), 300-306.*
3. (a) Rühlmann, K. *Chem. Ber.* **1961**, *94*, 2311-2313. (b) Zeiss, W.; Feldt, C.; Weis, J. *Chem. Ber.* **1978**, *111*, 1180-1194 (c) Bestmann, H. J.; Wölfel, G. *Chem. Ber.* **1984**, *117*, 1250-1254. (d) Bestmann, H. J.; Wölfel, G. *Angew. Chem., Int. Ed. Engl.* **1984**, *23*(1), 53. (e) Refvik, M. D.; Schwan, A. L. *J. Org. Chem.* **1996**, *61*, 4232-4239.
4. Mantri, P.; Duffy, D. E.; Kettner, C. A. K. *J. Org. Chem.* **1996**, *61*, 5690-5692.
5. For silver iodide mediated aminations of allylic chlorides with lithium bis(trimethylsilyl)amide see: Murai, T.; Yamamoto, M.; Kondo, S.; Kato, S. *J. Org. Chem.* **1993**, *58*, 7440-7445.
6. Heck, R.F. Palladium Reagents in Organic Synthesis, Academic Press **1985**, pp. 122-130
7. For an example of lithium bis(trimethylsilyl)amide as a hindered base in palladium(0) catalyzed aminations of arylbromides see: Louie, J.; Hartwig, J. F. *Tetrahedron Lett.* **1996**, *36*(21), 3609-3612.
8. Spectroscopic Data: ^1H NMR ($CDCl_3$, 250 MHz): δ = 5.7-5.82 (1H, m), 4.94-5.14 (2H, m), 3.41 - 3.44 (2H, m), 0.07 (18H, s) ppm. ^{13}C NMR ($CDCl_3$, 63 Mhz): δ = 141 (CH), 113 (CH_2), 47 (CH_2),1.9 (CH_3) ppm
9. The lower isolated yield was attributed partially to codistillation of allylHMDS with the reaction solvent toluene and decomposition during distillation. Based on GC analysis of the crude reaction mixture, no significant hydrolysis occured during the aqueous workup.
10. Binger, P.; Wedemann, P.; Goddard, R.; Brinker ,U.H. *J. Org Chem.* **1996**, *61*, 6462-6464.
11. (a) Von Matt, P.; Loiseleur, O.; Koch, G.; Pfaltz, A.; Lefeber, C.; Feucht, T.; Helmchen, G. *Tetrahedron: Asymmetry* **1994**, *5*(4), 573-584. (b) Jumnah, R.; Williams, A. C.; Williams, J. M. J. *Synlett* **1995(8)**, 821.

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