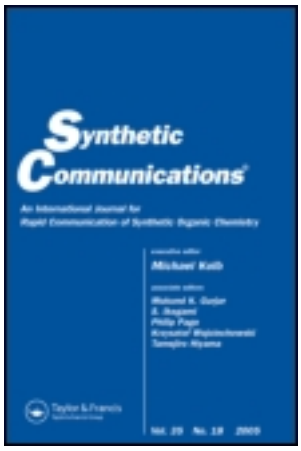


Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lsyc20

Substitution of the Benzotriazolyl Group in N-(α-Amidoalkyl)benzotriazoles and N-(α-Sulfonamidoalkyl)benzotriazoles with Allylsamarium Bromide

Xiaoxia Wang [a], Jian Li [a] & Professor Yongmin Zhang [a b]

[a] Department of Chemistry, Zhejiang University (Campus Xixi), Hangzhou, P.R. China

[b] State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, Shanghai, P.R. China

Version of record first published: 15 Aug 2006.

To cite this article: Xiaoxia Wang, Jian Li & Professor Yongmin Zhang (2003): Substitution of the Benzotriazolyl Group in N-(α-Amidoalkyl)benzotriazoles and N-(α-Sulfonamidoalkyl)benzotriazoles with Allylsamarium Bromide, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 33:20, 3575-3581

To link to this article: http://dx.doi.org/10.1081/SCC-120024744

MARCEL DEKKER, INC. • 270 MADISON AVENUE • NEW YORK, NY 10016

SYNTHETIC COMMUNICATIONS®
Vol. 33, No. 20, pp. 3575–3581, 2003

Substitution of the Benzotriazolyl Group in *N*-(α-Amidoalkyl)benzotriazoles and *N*-(α-Sulfonamidoalkyl)benzotriazoles with Allylsamarium Bromide

Xiaoxia Wang,[1] Jian Li,[1] and Yongmin Zhang[1,2,*]

[1]Department of Chemistry,
Zhejiang University (Campus Xixi),
Hangzhou, P.R. China
[2]State Key Laboratory of Organometallic Chemistry,
Shanghai Institute of Organic Chemistry,
Chinese Academy of Sciences, Shanghai, P.R. China

ABSTRACT

The nucleophilic substitution of the benzotriazolyl group in the *N*-(α-benzotriazol-1-ylalkyl)amides and *N*-(α-benzotriazol-1-ylalkyl) sulfonamides with allylsamarium bromide was investigated, and the

*Correspondence: Yongmin Zhang, Professor, Department of Chemistry, Zhejiang University (Campus Xixi), Tianmu-Shan Road, Hangzhou, 310028, P.R. China; State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, Shanghai, 200032, P.R. China; Fax: 86-571-8807077; E-mail: yminzhang@mail.hz.zj.cn.

DOI: 10.1081/SCC-120024744 0039-7911 (Print); 1532-2432 (Online)

MARCEL DEKKER, INC. • 270 MADISON AVENUE • NEW YORK, NY 10016

corresponding homoallylamides or homoallylsulfonamides were obtained in good to excellent yields.

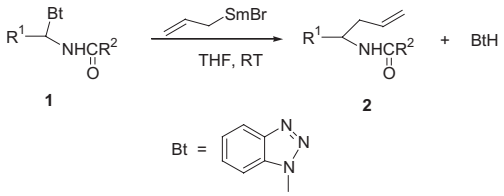
Key Words: *N*-(α-Amidoalkyl)benzotriazoles; *N*-(α-Sulfonamidoalkyl)benzotriazoles; Allylsamarium bromide; Homoallylamide; Homoallylsulfonamide.

Benzotriazole is a very useful synthetic auxiliary[1] and its application in organic chemistry has been extensively investigated. Elimination of the benzotriazolyl group at an appropriate stage is an important aspect in benzotriazole chemistry. Of the various methods available for the removal of benzotriazolyl group, replacement of the benzotriazolyl group with nucleophilic reagents has afforded many kinds of useful and interesting compounds.[1e]

Organosamarium reagent allylsamarium bromide is an excellent allylation reagent due to its advantageous properties already exploited in organic synthesis. The nucleophilic addition reactions promoted by allylsamarium bromide with nitriles,[2] oximes,[3] lactames, lactones and acyclic amides[4] to give the corresponding diallylation products has been well investigated. Herein we wish to report the nucleophilic substitution reaction promoted by allylsamarium bromide.

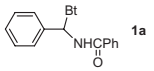
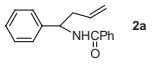
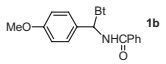
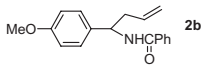
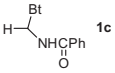
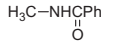
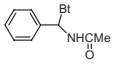
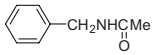
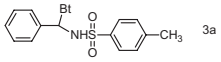
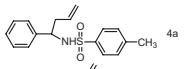
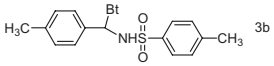
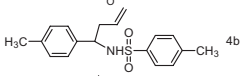
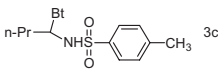
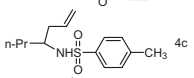
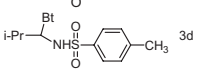
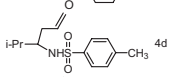
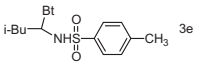
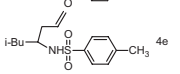
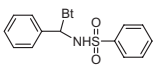
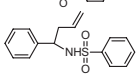
Allylsamarium bromide has been reported to substitute the benzotriazolyl group in *N*-aminoalkylbenzotriazoles, thus providing a useful method for the preparation of a variety of secondary and tertiary homoallylamines.[5] The similarity between *N*-(α-amidoalkyl)benzotriazoles (readily obtained from amides, aldehydes, and benzotriazole) and *N*-aminoalkylbenzotriazoles (easily available from amines, aldehydes and benzotriazole) prompted us to investigate the possibility of preparing homoallylamides via the nucleophilic substitution of the benzotriazolyl group in the *N*-(α-amidoalkyl)benzotriazoles with allylsamarium bromide (Sch. 1).

The study initiated with substrate **1a** ($R^1=R^2=C_6H_5$). When **1a** was treated with allylsamarium bromide, the characteristic purple color of



Scheme 1.

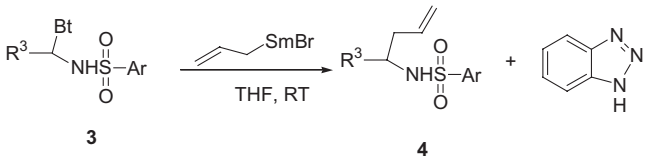
Table 1. Replacement of the benzotriazolyl group in the *N*-(α-amidoalkyl)-benzotriazoles and *N*-(α-sulfonamidoalkyl)benzotriazoles with allylsamarium bromide.

Entry	Substrate	Product	Yields[a] (%)
1	 **1a**	 **2a**	74
2	 **1b**	 **2b**	69
3	 **1c**		76
4	 **1d**		82
5	 3a	 4a	96
6	 3b	 4b	96
7	 3c	 4c	95
8	 3d	 4d	93
9	 3e	 4e	92
10	 3f	 4f	97

[a]Yields of isolated products.

allylsamarium bromide faded immediately. Routine work-up afforded a new compound, which was characterized as product **2a** via its IR, ^{1}H-NMR and MS spectral data. However, it was found that when either R^1 or R^2 in substrate **1** is an alkyl, product **2** could not be afforded and the only product obtained was that resulting from the reductive elimination of benzotriazole (Table 1**,** Entries 3 and 4). The formation of the reduction product may be attributed to the reductive ability inherent of the two-valent samarium in the allylsamarium bromide.

To further explore the generality of the reaction, it is reasonable to extend the substrates to *N*-(α-sulfonamidoalkyl)benzotriazoles, which are the analogues of *N*-(α-amidoalkyl)benzotriazoles and are easily prepared from sulfonamides, aldehydes, and benzotriazole. As shown in Sch. 2, the benzotriazolyl group in the *N*-(α-sulfonamidoalkyl)benzotriazoles can



Scheme 2.

be replaced by allylsamarium bromide and give the corresponding homoallylsulfonamides smoothly.

It is satisfying to note that no matter R^3 in compound **3** is an aryl or alkyl, products **4** can always be obtained in almost quantitative yields (Table 1).

In conclusion, the benzotriazolyl group in the *N*-(α-amidoalkyl)-benzotriazoles and *N*-(α-sulfonamidoalkyl)benzotriazoles can be replaced by allylsamarium bromide. The readily available starting materials, the mild reaction conditions and the excellent yields make the reaction reported here an attractive one for the preparation of homoallylamides and homoallylsulfonamides.

EXPERIMENTAL

Tetrahydrofuran was distilled from sodium-benzophenone immediately prior to use. All reactions were conducted under a nitrogen atomsphere. Melting points are uncorrected. ^{1}H NMR spectra were recorded on a Bruker 400 MHz instrument as $CDCl_3$ solutions using TMS as internal standard. Chemical shifts (δ) are reported in ppm and coupling constants *J* is given in Hz. IR spectra were recorded using KBr disks with a Bruker Vector-22 infrared spectrometer. Elemental analyses were performed on a EA-1110 instrument. Substrates **1a–1d**[6] and **3a–3f**[7] are prepared according to literature procedures.

General procedure for the replacement of the benzotriazolyl group with allylsamarium bromide. Under an inert atmosphere of nitrogen, powdered samarium (0.30 g, 2.0 mmol) was placed in a 50 mL two-necked flask and allylbromide (0.27 g, 2.2 mmol) in 1 mL THF was added by syringe. After subsequent addition of a catalytic amount of iodine, the mixture was magnetically stirred for 1 h at room temperature to obtain a purple suspension. Then a solution of *N*-(α-amidoalkyl)benzotriazoles or *N*-(α-sulfonamidoalkyl)benzotriazoles (1 mmol) in 4–6 mL of THF was added to the suspension in one portion by syringe. The purple color faded immediately and the mixture was stirred for 5 min more. The reaction

was quenched with 0.1 M hydrochloric acid (5 mL) and extracted with ether (3×10 mL). The organic layer was washed with brine and dried over anhydrous Na_2SO_4. The solvent was removed by evaporation under reduced pressure. The crude product was purified by preparative TLC on silica gel (cyclohexane/ethyl acetate = 3:1 as eluent).

Compound 2a. M.p.: 118–120°C. ν_{max} (KBr)/cm^{-1}: 3349, 3054, 3030, 1635, 1603. δ_H ($CDCl_3$): 7.77 (2H, d, *J* 8.4 Hz), 7.28–7.52 (8H, m), 6.41 (1H, d, br, *J* 7.2 Hz), 5.74–5.81 (1H, m), 5.27–5.32 (1H, apparent q, *J* 6.8 Hz), 5.12–5.21 (2H, m), 2.70 (2H, apparent t, *J*. 6.8 Hz). *m*/*z* (%): 251 (M^+, 0.61), 210 (30.96), 105 (100). Anal. calcd. for $C_{17}H_{17}NO$: C, 81.24; H, 6.82; N, 5.57. Found: C, 81.33; H, 6.85; N, 5.52%.

Compound 2b. M.p.: 123–125°C. ν_{max} (KBr)/cm^{-1}: 3340, 2959, 1633, 1532. δ_H ($CDCl_3$): 7.77–7.79 (2H, m), 7.43–7.54 (3H, m), 7.29–7.31 (2H, m), 6.89–6.92 (2H, m), 6.37 (1H, d, br, *J* 6.8 Hz), 5.76–5.83 (1H, m), 5.12–5.27 (3H, m), 3.82 (3H, s), 2.68–2.73 (2H, m). *m*/*z* (%): 281 (M^+, 0.52), 240 (32.26), 105 (100). Anal. calcd. for $C_{18}H_{19}NO_2$: C, 76.84; H, 6.81; N, 4.98. Found: C, 76.89; H, 6.87; N, 4.91%.

Compound 4a. M.p.: 76–77°C (Lit.[8] 76–77°C). ν_{max} (KBr)/cm^{-1}: 3259, 3062, 2897, 1642, 1600, 1497. δ_H ($CDCl_3$): 7.56–7.58 (2H, d, *J* 8.4 Hz), 7.08–7.34 (7H, m), 5.47–5.58 (1H, m), 4.92–5.09 (3H, m), 4.39 (1H, apparent q, *J* 6.8 Hz), 2.41–2.60 (5H, m).

Compound 4b. M.p.: 118–120°C (Lit.[8] 116–117°C). ν_{max} (KBr)/cm^{-1}: 3253, 3063, 2921, 1644, 1597, 1496. δ_H ($CDCl_3$): 7.58 (2H, d, *J* 8.4 Hz), 7.17 (2H, d, *J* 7.6 Hz), 6.96–7.02 (4H, m), 5.47–5.57 (1H, m), 5.04–5.09 (2H, m), 4.83 (1H, d, br, *J* 6.4 Hz), 4.34 (1H, apparent q, *J* 6.8 Hz), 2.44–2.53 (2H, m), 2.40 (3H, s), 2.30 (3H, s).

Compound 4c. M.p.: 87–88°C. ν_{max} (KBr)/cm^{-1}: 3273, 3071, 2959, 2936, 2874, 1642, 1599, 1495. δ_H ($CDCl_3$): 7.76 (2H, d, *J* 8.4 Hz), 7.31 (2H, d, *J* 8.4 Hz), 5.56–5.61 (1H, m), 4.95–5.06 (2H, m), 4.33 (1H, d, br, *J* 7.6 Hz), 3.30–3.33 (1H, m), 2.47 (3H, s), 2.11 (2H, apparent t, *J* 6.4 Hz), 1.22–1.46 (4H, m), 0.82 (3H, t, *J* 7.2 Hz). *m*/*z* (%): 268 ($M^+ + 1$, 1.41), 226 (59.75), 155 (58.36), 91 (100). Anal. calcd. for $C_{14}H_{21}NO_2S$: C, 62.89; H, 7.92; N, 5.24. Found: C, 62.82; H, 8.03; N, 5.21%.

Compound 4d. M.p.: 67–69°C. ν_{max} (KBr)/cm^{-1}: 3268, 3070, 2958, 2875, 1641, 1599, 1496. δ_H ($CDCl_3$): 7.76 (2H, d, *J* 8.0 Hz), 7.30 (2H, d, *J* 8.0 Hz), 5.46–5.54 (1H, m), 4.93–5.06 (2H, m), 4.42 (1H, d, br, *J* 8.0 Hz), 3.09–3.14 (1H, m), 2.44 (3H, s), 2.08 (2H, apparent t, *J* 6.4 Hz), 1.76–1.82 (1H, m), 0.84 (6H, d, *J* 7.2 Hz). *m*/*z* (%): 268 ($M^+ + 1$, 0.62), 226 (52.79), 155 (62.58), 91 (100). Anal. calcd. for $C_{14}H_{21}NO_2S$: C, 62.89; H, 7.92; N, 5.24. Found: C, 62.85; H, 7.99; N, 5.20%.

Compound 4e. M.p.: 70–71°C. ν_{max} (KBr)/cm^{-1}: 3274, 3070, 2958, 2933, 2871, 1642, 1600, 1497. δ_H ($CDCl_3$): 7.77 (2H, d, *J* 8.4 Hz), 7.31

(2H, d, *J* 8.4 Hz), 5.56–5.63 (1H, m), 4.94–5.07 (2H, m), 4.28 (1H, br), 3.34–3.40 (1H, m), 2.45 (3H, s), 2.11 (2H, m), 1.22–1.30 (2H, m), 0.75–0.92 (7H, m). *m*/*z* (%): 282 ($M^+ + 1$, 1.52), 240 (61.12), 155 (55.56), 91 (100). Anal. calcd. for $C_{15}H_{23}NO_2S$: C, 64.02; H, 8.24; N, 4.98. Found: C, 64.12; H, 8.27; N, 4.92%.

Compound 4f. M.p.: 79–81°C (Lit.[9] 80–81°C). ν_{max} (KBr)/cm^{-1}: 3251, 3060, 1641, 1600, 1496. δ_H ($CDCl_3$): 7.64–7.80 (2H, m), 7.28–7.53 (4H, m), 6.98–7.20 (4H, m), 5.48–5.62 (1H, m), 4.92–5.09 (3H, m), 4.39 (1H, apparent q, *J* 6.8 Hz), 2.41 (2H, apparent t, *J* 7.2 Hz).

ACKNOWLEDGMENT

We are grateful to the National Natural Science Foundation of China (Project No. 20072033) and the Specialized Research Fund for the Doctoral Program of Higher Education of China for financial support.

REFERENCES

1. (a) Katritzky, A.R.; Rachwal, S.; Hitchings, G.J. A novel synthetic auxiliary. Tetrahedron **1991**, *47*, 2683; (b) Katritzky, A.R.; Yang, Z.; Cundy, D.J. Benzotriazole-stabilized carbanions: generation, reactivity and synthetic utility. Aldrichimica Acta **1994**, *27*, 31; (c) Katritzky, A.R.; Lan, X. Benzotriazole-mediated arylarylation and heteroarylalkylation. Chem. Soc. Rev. **1994**, 363; (d) Katritzky, A.R.; Lan, X.; Fan, W.Q. Benzotriazole as a synthetic auxiliary: benzotriaxolylalkylation and benzotriazole-mediated heteroalkylation. Synthesis **1994**, 445; (e) Katritzky, A.R.; Lan, X.; Yang, J.Z.; Denisko, O.V. Properties and synthetic utility of *N*-substituted benzotriazoles. Chem. Rev. **1998**, *98*, 409.
2. Yu, M.X.; Zhang, Y.M.; Guo, H.Y. The synthesis of homoallylaminised by the addition of oransamarium reagent to nitriles. Synth. Commun. **1997**, *27*, 1495.
3. Fan, X.S.; Zhang, Y.M. Preparation of dihomoallylic secondary amines through samarium mediated allylation of oximes. Tetrahedron Lett. **2002**, *43*, 5475.
4. (a) Li, Z.F.; Zhang, Y.M. Direct construction of quaternary carbon center utilizing an organosamarium reagent. Tetrahedron Lett. **2001**, *42*, 8507; (b) Li, Z.F.; Zhang, Y.M. Direct construction of quaternary

carbon center utilizing an allylsamarium bromide reagent. Tetrahedron **2002**, *58*, 5301.
5. Wang, J.; Zhou, J.; Zhang, Y. Facile preparation of homoallylamines via reaction of *N*-aminoalkylbenzotriazoles with allylsamarium bromide. Synth. Commun. **1996**, *26*, 3395.
6. Katritzky, A.R.; Drewniak, M. The chemistry of benzotriazole. Part 8. A novel two-step procedure for the *N*-alkylation of amides. J. Chem. Soc. Perkin Trans. 1 **1988**, 2339.
7. Katritzky, A.R.; Oniciu, D.D.; Ghiviriga, I. Benzotriazole-assisted synthesis of *N*-(α-cyanoalkyl)sulfonamides. Synth. Commun. **1997**, *27*, 907.
8. Liu, Y.K.; Zhang, Y.M. J. Chem. Res. (S) *in press*.
9. Lu, W.S.; Chan, T.H. Organometallic reactions in aqueous media. Indium- and zinc-mediated allylation of sulfonimines. J. Org. Chem. **2000**, *65*, 8589.

Received in Japan March 12, 2003

MARCEL DEKKER, INC. • 270 MADISON AVENUE • NEW YORK, NY 10016