CHEMISTRY LETTERS, pp. 1209-1212, 1980.

HIGHLY STEREOSELECTIVE SYNTHESIS OF TRISUBSTITUTED OLEFINS FROM ALKENYL ARYL SULFOXIDES

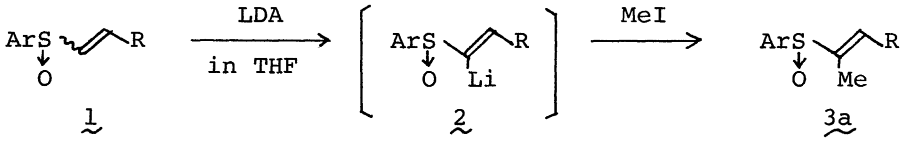
Hisashi TAKEI, Hideyuki SUGIMURA, Morikazu MIURA, and Hisashi OKAMURA
Department of Life Chemistry, Tokyo Institute of Technology
Nagatsutacho, Midoriku, Yokohama 227

Alkenyl aryl sulfoxides could be alkylated stereoselectively via their lithium salts to afford α-alkylated (E)-alkenyl sulfoxides. Reduction of the sulfoxides to the corresponding sulfides followed by nickel-phosphine complexes catalyzed coupling reaction with Grignard reagents gave trisubstituted olefins.

Trisubstituted olefins exist in various natural occuring products and, as a result, a number of methods for the stereoselective synthesis of the olefins have been developed.$^{1)}$

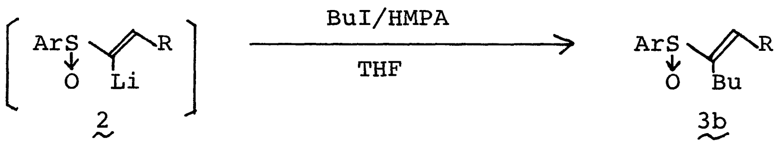
In this communication, we wish to report the highly stereoselective synthesis of trisubstituted olefins utilizing the method for stereoselective alkylation of alkenyl sulfoxides$^{2)}$ and the coupling reaction of alkenyl sulfides with Grignard reagents catalyzed by nickel-phosphine complexes.$^{3)}$

Previously, we found that the alkenyl anions, derived from alkenyl aryl sulfoxides (mixture of E,Z isomers), reacted stereoselectively with methyl iodide in THF to give the methylated (E)-alkenyl sulfoxides (Eq. 1).$^{2)}$



(Eq. 1)

Similarly, we examined the reaction of alkenyl anion 2 with butyl iodide. However, the reaction hardly proceeded and (E)-alkenyl sulfoxide 1 was recovered. This difficulty was overcome by the addition of HMPA to the reaction mixture, as follows. The sulfoxide 1 was converted to the corresponding alkenyl anion 2 by treatment with LDA in THF at -100°C. To the solution, butyl iodide in THF and then an equimolar amount of HMPA were added and the reaction mixture was stirred for several hours at -78°C or -40∼-30°C. The butylated (E)-alkenyl sulfoxides were obtained in high yields (Eq. 2) (Table I).



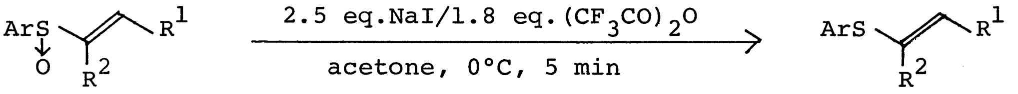
(Eq. 2)

Table I. Alkylation of Alkenyl Aryl Sulfoxides.

run	Ar	R	E/Z[a),b)]	RX	Alkylation Cond.		Yield(%)[c)]	E/Z[a)]
					Temp.(°C)	Time(h)		
1	Ph	CH_2CH_2Ph	1	MeI	-100	0.5	89	≫10
2	Ph	CH_2OSiMe_2t-Bu	≫10	MeI	-100	2	62	≫10
3	2-pyridyl	CH_2CH_2Ph	2	MeI	-100	0.5	99	≫10
4	2-pyridyl	CH_2OSiMe_2t-Bu	1.8	MeI	-100	2	91	≫10
5	Ph	CH_2CH_2Ph	1	BuI[d)]	-78	0.5	<76[e)]	≫10
6	2-pyridyl	CH_2CH_2Ph	2	BuI[d)]	-100	3	38	≫10
7	2-pyridyl	CH_2CH_2Ph	2	BuI[d)]	-78	3	70	≫10
8	2-pyridyl	CH_2CH_2Ph	2	BuI[d)]	-40～-30	3.5	82	≫10

a) Ratio was determined by nmr. b) Ratio for starting sulfoxides. c) Yields of isolated products by tlc. d) An equimolar amount of HMPA was added. e) Contaminated with a small amount of the isomer, PhS(O)CH(Bu)CH=CHCH_2Ph.

Next, we examined the stereospecific reduction of the (E)-alkenyl sulfoxides to the corresponding sulfides by using trifluoroacetic anhydride and sodium iodide (Eq. 3). This reduction method was reported by Oae et al.[4)] for simple alkyl or aryl sulfoxides leading to the corresponding sulfides. We successfully applied this method to alkenyl aryl sulfoxides[5)] and the desired sulfides were obtained in high yields as shown in Table II.



(Eq. 3)

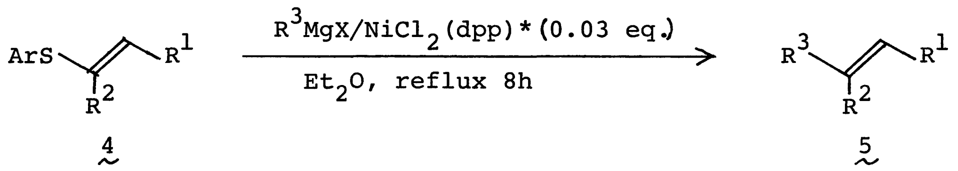
3 4

Table II. Reduction of Alkenyl Aryl Sulfoxides 3.

run	Ar	R^1	R^2	Yield(%)[a)]
1	2-pyridyl	CH_2CH_2Ph	Me	88
2	2-pyridyl	CH_2CH_2Ph	Bu	95
3	2-pyridyl	CH_2OSiMe_2t-Bu	Me	98
4	2-pyridyl	CH_2OSiMe_2t-Bu	$CH_2CH_2CH{=}CMe_2$	84
5	Ph	CH_2CH_2Ph	Me	96[b)]

a) Yields of isolated products by tlc. b) Reduction under the conditions shown in Eq. 3 resulted a complex mixture, but it proceeded cleanly under the following conditions: 3.7 eq. NaI/1.2 eq. pyridine/1.8 eq. $(CF_3CO)_2O$, 0°C, 10 min.

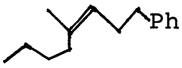
The alkenyl aryl sulfides thus obtained were successfully led to trisubstituted olefins stereoselectively by using the nickel-phosphine complexes catalyzed coupling reaction (Eq. 4) (Table III).[3),6),7)] It is worthy to note that stereoisomeric purities of the products were more than 99% in all cases.



(Eq. 4)

*dpp = $Ph_2PCH_2CH_2CH_2PPh_2$

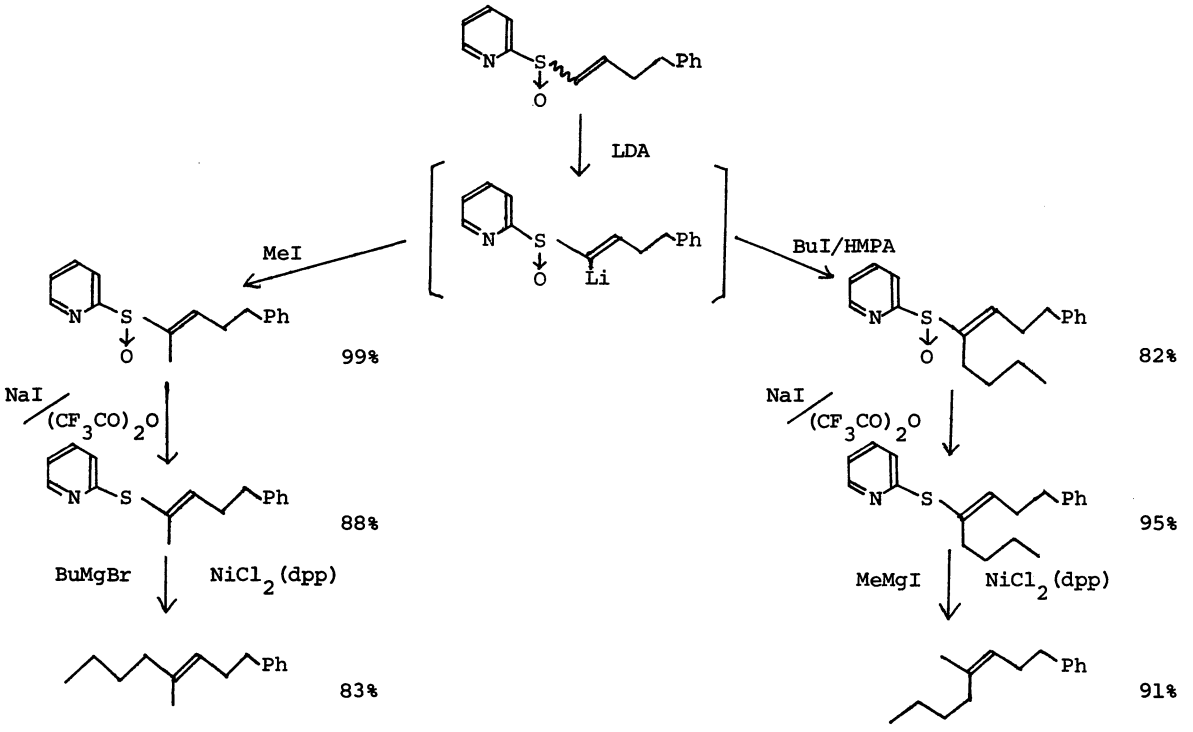
Table III. Synthesis of Trisubstituted Olefins[7)]

run	Ar	R^2	R^1	Grignard reagent(eq.)	Product[a)]	Yield(%)[b)]
1	2-pyridyl	Me	CH_2CH_2Ph	PhMgBr (2.5)		75
2	2-pyridyl	Me	CH_2CH_2Ph	BuMgBr (2.5)		79 (83)
3	2-pyridyl	Bu	CH_2CH_2Ph	MeMgI (2.5)		81 (91)
4	Ph	Me	CH_2CH_2Ph	BuMgBr (2.5)		(64)

a) The structures of the products were confirmed by comparison with authentic samples.[8)] Isomeric purities of the products were more than 99% (by glpc).

b) Yields of isolated products by tlc. The number in parentheses is a yield determined by glpc.

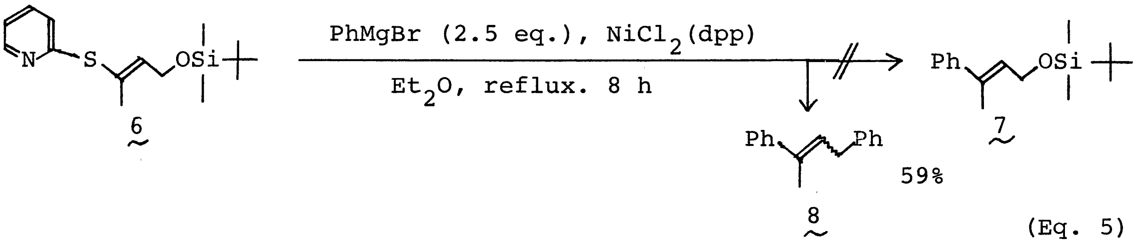
In conclusion, the reaction sequence, described above and summarized in the following Scheme, provides a useful and highly stereoselective synthetic method of trisubstituted olefins.



Scheme

References and Notes

1) A. Marfat, P. R. McGuirk, and P. Helquist, J. Org. Chem., 44, 3888 (1979) and the references cited therein.
2) H. Okamura, Y. Mitsuhira, M. Miura, and H. Takei, Chem. Lett., 1978, 517. After our publication, a similar description about the generation and (Z)-(E) isomerization of 1-arylsulfinyl-1-alken-1-yl lithium appeared: G. H. Posner, P. -W. Tang, and J. P. Mallamo. Tetrahedron Lett., 1978, 3995.
3) H. Okamura, M. Miura, and H. Takei, Tetrahedron Lett., 1979, 43. A similar coupling reaction in benzene was reported recently: E. Wenkert, T. W. Ferreira, and E. L. Michelotti, J. Chem. Soc., Chem. Commun., 1979, 637.
4) J. Drabowicz and S. Oae, Synthesis, 1977, 404.
5) Recently, the method for stereospecific reduction of alkenyl sulfoxides was reported: G. H. Posner and T. -W. Tang, J. Org. Chem., 43, 4131 (1978). We applied this method to our alkenyl aryl sulfoxides, but this method had little adventage over the present one.
6) We also examined the similar coupling reaction using the corresponding sulfoxides or sulfones, but the results were unsatisfactory.
7) The nickel-phosphine complex catalyzed coupling reaction of the sulfide **6** with BuMgBr (2.5 eq.) gave a complex mixture, but the reaction with PhMgBr (2.5 eq.) gave **8** (59%; E:Z=6:1). The structure of the product was confirmed by comparison with the authentic sample. On the other hand, it was reported that allylic alcohols coupled with Grignard reagents in the presence of nickel complexes to give the corresponding hydrocarbones9). Therefore these results can be explained by assuming that the desired coupling reaction competes with the coupling between Grignard reagent and allylic residue of the silyl ether (Eq. 5).



(Eq. 5)

8) Authentic samples were obtained by the Wittig reaction as stereoisomeric mixtures. The intermediate sulfoxides and sulfides gave nmr spectral data which are in accordance with their assigned structures.2) Satisfactory combustion analyses were obtained on the sulfides.
9) C. Chuit, H. Felkin, C. Frajerman, G. Roussi, and G. Swierczewski, J. Chem. Soc., Chem. Commun., 1968, 1604. H. Felkin and G. Swierczewski, Tetrahedron Lett., 1972, 1433.

(Received July 10, 1980)