JOURNAL OF CHEMICAL RESEARCH 2005 SEPTEMBER, 583–584 **RESEARCH PAPER** 583

A facile stereoselective synthesis of (*E*)-1,2-disubstituted vinyl sulfides via hydromagnesiation of alkylarylacetylenes

Mingzhong Cai[a]*, Jun Xia[a] and Pingping Wang[b]

[a] *Department of Chemistry, Jiangxi Normal University, Nanchang 330027, P. R. China*

[b] *Department of Chemistry, Jiujiang College, Jiujiang 332000, P. R. China*

Hydromagnesiation of alkylarylacetylenes **1** in diethyl ether gave (*E*)-α-arylvinyl Grignards reagents **2**, which reacted with arylsulfenyl chlorides **3** to afford stereoselectively (*E*)-1,2-disubstituted vinyl sulfides **4** in good yields.

Keywords: hydromagnesiation, vinyl sulfide, arylsulfenyl chloride, alkylarylacetylene, stereoselective synthesis

Vinyl sulfides are promising synthetic intermediates which can participate in highly stereoselective carbon-carbon bond formation processes.[1] They may be prepared by a variety of methods.[2] However, only few of these methods afford products of high stereoisomeric purity. The addition of an organocopper or cuprate species to an alkynylthioether affords highly pure 1-alkenyl sulfides.[3] The cleavage of a disulfide by a 1-alkenyllithium reagents or 1-alkenylcopper reagents is another method for the stereoselective synthesis of 1-alkenyl sulfides.[4] However, the starting materials such as organocopper, 1-alkenyllithium and 1-alkenylcopper reagents are not easily available.

Hydromagnesiation has emerged as a unique hydrometallation with some attractive features such as the high regio-selectivity and stereoselectivity observed with alkylarylacetylenes[5] and alkynylsilanes.[6] Very recently, we have reported the stereoselective syntheses of (*Z*)-2-trimethylsilyl-substituted allylic alcohols,[7] (*E*)-α-selenenylvinylsilanes,[8] 1,3-dienylsilanes[9] and (*E*)-α-aryltellurenylvinylsilanes[10] by the hydromagnesiation of alkynylsilanes. Herein we report that (*E*)-1,2-disubstituted vinyl sulfides can be conveniently synthesised via the hydromagnesiation of alkylarylacetylenes, followed by the reaction with arylsulfenyl chlorides (Scheme 1).

Alkylarylacetylenes **1** were prepared according to the literature procedure.[11] Hydromagnesiation of alkylarylacetylenes **1** at 25 °C in diethyl ether for 1 h gave (*E*)-α-arylvinyl Grignard reagents **2**, which reacted with arylsulfenyl chlorides **3** to afford stereoselectively (*E*)-1,2-disubstituted vinyl sulfides **4** in good yields. The typical results are summarised in Table 1.

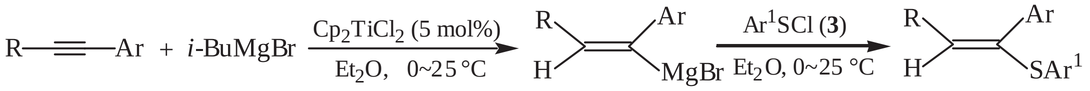
Investigations of the crude products **4** by ^{1}H NMR spectroscopy (400 MHz) showed their isomeric purities to be more than 97%. One olefinic proton signal of compounds **4a–h** splits characteristically into one triplet at $\delta = 6.02–6.19$ with coupling constant $J = 7.6$ Hz. This indicated that the hydromagnesiation of the alkylarylacetylenes had taken place with strong preference for the addition of the magnesium atom at the carbon adjacent to the aryl group.

Experimental

Diethyl ether was distilled from sodium immediately prior to use. IR spectra were obtained on a Perkin-Elmer 683 instrument as neat films. ^{1}H NMR spectra were recorded on a Bruker AC-400 (400 MHz) spectrometer using $CDCl_3$ as solvent. Microanalyses were measured using a Yanaco MT-3 CHN microelemental analyser. Arylsulfenyl chlorides **3** were prepared according to literature method.[12]

General procedure for the synthesis of (E)-1,2-disubstituted vinyl sulfides **4a–h**: To a solution of isobutylmagnesium bromide (2.5 mmol) in diethyl ether (4 ml) was added Cp_2TiCl_2 (25 mg, 0.1 mmol) at 0 °C under Ar, and the mixture was stirred for 30 min at that temperature. To this solution was added alkylarylacetylene **1** (2.1 mmol), and the mixture was stirred for 1 h at 25 °C. After being cooled to 0 °C, a solution of arylsulfenyl chloride **3** (2.0 mmol) in Et_2O (2 ml) was added dropwise over 20 min with stirring and the mixture was stirred for 8 h at 25 °C, quenched with sat. aq NH_4Cl (15 ml) and extracted with Et_2O (2 × 30 ml). The organic layer was washed with sat. aq NH_4Cl (20 ml) and water (3 × 20 ml) and dried ($MgSO_4$). Removal of the solvent under reduced pressure gave an oil, which was purified by column chromatography on silica gel using light petroleum as the eluent.

4a: IR(film): ν(cm^{-1}) 3074, 3021, 2956, 2927, 2855, 1680, 1589, 1489, 738, 700; ^{1}H NMR: δ_H 7.35–7.11 (m, 10H), 6.14 (t, $J = 7.6$ Hz, 1H), 2.13 (m, 2H), 1.38–1.24 (m, 4H), 0.84 (t, $J = 7.2$ Hz, 3H); Anal. Calcd. for $C_{18}H_{20}S$: C, 80.60; H, 7.46. Found: C, 80.33; H, 7.35.



1 **2** **4**

Scheme 1

Table 1 Synthesis of (*E*)-1,2-disubstituted vinyl sulfides **4a–h**

Entry	R	Ar	Ar^1	Product	Yield/%[a]
1	n-C_4H_9	Ph	Ph	**4a**	61
2	n-C_4H_9	4-ClC_6H_4	Ph	**4b**	75
3	n-C_6H_{13}	Ph	Ph	**4c**	80
4	n-C_4H_9	4-$CH_3C_6H_4$	Ph	**4d**	62
5	n-C_4H_9	4-$CH_3C_6H_4$	4-$CH_3C_6H_4$	**4e**	78
6	n-C_4H_9	4-ClC_6H_4	4-$CH_3C_6H_4$	**4f**	68
7	n-C_4H_9	4-ClC_6H_4	4-ClC_6H_4	**4g**	77
8	n-C_6H_{13}	Ph	4-$CH_3C_6H_4$	**4h**	82

[a] Isolated yield based on the arylsulfenyl chloride **3** used.

---

* Correspondent. E-mail: caimingz@tom.com

4b: IR(film): ν(cm^{-1}) 3059, 3017, 2957, 2928, 2858, 1610, 1583, 1487, 827, 739, 690; ^{1}H NMR: δ_H 7.51–7.10 (m, 9H), 6.18 (t, *J* = 7.6 Hz, 1H), 2.11 (m, 2H), 1.39–1.24 (m, 4H), 0.83 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{18}H_{19}SCl$: C, 71.40; H, 6.28. Found: C, 71.19; H, 6.03.

4c: IR(film): ν(cm^{-1}) 3058, 3019, 2954, 2925, 2857, 1681, 1579, 1477, 899, 758, 739, 698; ^{1}H NMR: δ_H 7.36–7.10 (m, 10H), 6.14 (t, *J* = 7.6 Hz, 1H), 2.13 (m, 2H), 1.38–1.19 (m, 8H), 0.83 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{20}H_{24}S$: C, 81.08; H, 8.11. Found: C, 80.81; H, 7.90.

4d: IR(film): ν(cm^{-1}) 3057, 3022, 2957, 2926, 2858, 1614, 1591, 1489, 804, 738, 740; ^{1}H NMR: δ_H 7.47–7.04 (m, 9H), 6.12 (t, *J* = 7.6 Hz, 1H), 2.29 (s, 3H), 2.16 (m, 2H), 1.38–1.27 (m, 4H), 0.87 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{19}H_{22}S$: C, 80.85; H, 7.80. Found: C, 80.59; H, 7.69.

4e: IR(film): ν(cm^{-1}) 3058, 3021, 2957, 2924, 2859, 1608, 1567, 1508, 1492, 1457, 892, 806; ^{1}H NMR: δ_H 7.44–6.92 (m, 8H), 6.15 (t, *J* = 7.6 Hz, 1H), 2.27 (s, 3H), 2.21 (s, 3H), 2.10 (m, 2H), 1.34–1.23 (m, 4H), 0.87 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{20}H_{24}S$: C, 81.08; H, 8.11. Found: C, 80.91; H, 8.16.

4f: IR(film): ν(cm^{-1}) 3071, 3020, 2957, 2925, 2859, 1591, 1566, 1488, 1396, 891, 827, 805; ^{1}H NMR: δ_H 7.39–6.96 (m, 8H), 6.08 (t, *J* = 7.6 Hz, 1H), 2.31 (s, 3H), 2.07 (m, 2H), 1.36–1.20 (m, 4H), 0.83 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{19}H_{21}SCl$: C, 72.04; H, 6.64. Found: C, 71.75; H, 6.41 .

4g: IR(film): ν(cm^{-1}) 3059, 3020, 2958, 2921, 2856, 1591, 1487, 1475, 1377, 1093, 1013, 816; ^{1}H NMR: δ_H 7.38–7.12 (m, 8H), 6.19 (t, *J* = 7.6 Hz, 1H), 2.12 (m, 2H), 1.36–1.21 (m, 4H), 0.84 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{18}H_{18}SCl_2$: C, 64.09; H, 5.34. Found: C, 63.82; H, 5.13.

4h: IR(film): ν(cm^{-1}) 3055, 3019, 2955, 2926, 2855, 1680, 1597, 1575, 1491, 1377, 805, 761, 699; ^{1}H NMR: δ_H 7.33–6.98 (m, 9H), 6.02 (t, *J* = 7.6 Hz, 1H), 2.25 (s, 3H), 2.09 (m, 2H), 1.38–1.19 (m, 8H), 0.85 (t, *J* = 7.2 Hz, 3H); Anal. Calcd. for $C_{21}H_{26}S$: C, 81.29; H, 8.39. Found: C, 81.02; H, 8.21.

We thank the National Natural Science Foundation of China (Project No. 20462002) and the Natural Science Foundation of Jiangxi Province in China (0420015) for financial support.

Received 24 March 2005; accepted 10 April 2005
Paper 05/3141

References

1 (a) B.M. Trost and A.C. Lavoie, *J. Am. Chem. Soc.*, 1983, **105**, 5075; (b) V. Fiandanese, G. Marchese, F. Naso and L. Ronzini, *J. Chem. Soc., Chem. Commun.*, 1982, 647; (c) T.-Y. Luh and Z.-J. Ni, *Synthesis*, 1990, 89; (d) F. Babudri, V. Fiandanese, L. Mazzone and F. Naso, *Tetrahedron Lett.*, 1994. **35**, 8847.
2 (a) M. Kakimoto, T. Yamamoto and M. Okawara, *Tetrahedron Lett.*, 1979, 623; (b) T. Cohen, G. Herman, J.R. Falck and A.J. Mura, *J. Org. Chem.*, 1975, **40**, 812; (c) H.C. Brown and M.H. Rei, *J. Am. Chem. Soc.*, 1969, **91**, 5646.
3 A. Alexakis, G. Cahiez, J.F. Normant and J. Villieras, *Bull. Soc. Chim. Fr.*, 1977, 693.
4 (a) B.J. Wakefield, in: *Comprehensive Organometallic Chemistry*, Vol. **7**, G. Wilkinson, Ed., Pergamon Press, Oxford, 1982, p.1; (b) A. Alexakis and J.F. Normant, *Synthesis*, 1985, 72.
5 F. Sato, H. Ishikawa and M. Sato, *Tetrahedron Lett.*, 1981, **22**, 85.
6 F. Sato, H. Watanabe, Y. Tanaka, T. Yamaji and M. Sato, *Tetrahedron Lett.*, 1983, **24**, 1041.
7 M. Cai, C. Peng, H. Zhao and W. Hao, *J. Chem. Res.*, 2003, 296.
8 H. Zhao and M. Cai, *Synthesis*, 2002, 1347.
9 M. Cai, W. Hao, H. Zhao and C. Song, *J. Organomet. Chem.*, 2003, **679**, 14.
10 M. Cai, W. Hao, H. Zhao and J. Xia, *J. Organomet. Chem.*, 2004, **689**, 1714.
11 M. Alami, F. Ferri and G. Linstrumelle, *Tetrahedron Lett.*, 1993, **34**, 6403.
12 D.N. Harpp, B.T. Friedlander and R.A. Smith, *Synthesis*, 1979, 181.