ethanol); ^{1}H NMR (DMSO-d_6) δ 10.90 (1 H, s, OH), 8.49 (1 H, dd, J = 1.9, 4.8, 7-H), 8.17 (1 H, d, J = 4.9, 2-H), 8.03 (1 H, dd, J = 1.9, 7.6, 9-H), 7.24 (1 H, dd, J = 4.8, 7.6, 8-H), 7.13 (1 H, d, J = 4.9, 3-H), 3.63 (1 H, m, 13-H), 2.36 (3 H, s, 12-H), 0.91 (2 H, m, 14- or 15-H), 0.41 (2 H, m, 14- or 15-H); MS (CI) m/z 283 (M + H$^+$). Anal. Calcd for $C_{15}H_{14}N_4O_2 \cdot 0.25H_2O$: C, 62.83; H, 5.06; N, 19.54. Found: C, 63.07; H, 5.18; N, 19.45.

Optimized Procedure for Preparation of 2. To a stirred suspension of 1 (0.511 g, 1.92 mmol) in dry THF (20 mL) cooled on ice was added LDA (1.5 M in cyclohexane, 1.5 mL, 2.25 mmol) dropwise. After a clear solution was obtained, the mixture was cooled below −40 °C and a further quantity of LDA (4.5 mL, 6.75 mmol) was added over 1 min resulting in a deep red solution. After 5 min, MoOPH (0.95 g, 2.19 mmol) was added as a solid all at once and the reaction mixture was stirred at −30 to −40 °C for 75 min. Acetic acid (2 mL) and water (30 mL) were added, and the mixture was extracted with ethyl acetate (100 mL, 2 × 50 mL). The combined organic phase was dried over sodium sulfate, filtered, and evaporated. Fractionation of the residue over silica gel (eluent, chloroform/ethanol gradient) gave the alcohol 2 (0.299 g, 1.06 mmol, 55%): mp 243–245 °C (ethyl acetate/hexane); ^{1}H NMR (DMSO-d_6) δ 9.74 (1 H, br s, NH), 8.52 (1 H, dd, J = 1.9, 4.8, 7-H), 8.20 (1 H, d, J = 4.9, 2-H), 8.01 (1 H, dd, J = 1.9, 7.6, 9-H), 7.26 (1 H, d, J = 4.9, 3-H), 7.20 (1 H, dd, J = 4.8, 7.6, 8-H), 5.26 (1 H, br s, OH), 4.76 (1 H, d, J = 5.5, 12-H), 4.53 (1 H, d, J = 5.5, 12-H), 3.63 (1 H, m, 13-H), 0.88 (2 H, m, 14- or 15-H), 0.36 (2 H, m, 14- or 15-H); MS (CI), 283 (M + H$^+$, 100). Anal. Calcd for $C_{15}H_{14}N_4O_2$: C, 63.82; H, 5.00, N, 19.85. Found: C, 63.86; H, 5.15; N, 19.86.

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Arylthio Amidation, Etherification, and Lactonization of Alkenes Promoted by Oxidation of Bis(4-methoxyphenyl) Disulfide with Ammonium Peroxydisulfate

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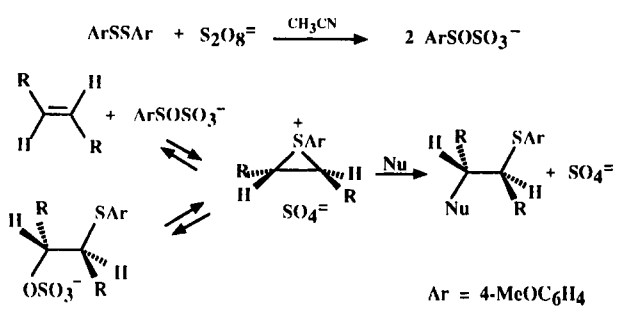
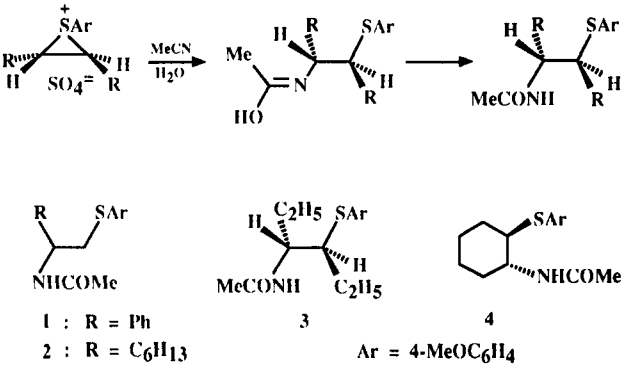
We have recently introduced the use of ammonium peroxydisulfate to effect the oxidation of diphenyl diselenide and to produce phenylselenenyl sulfate. Since the sulfate is a resonance-stabilized anion and a very poor nucleophile this reagent behaves as a very efficient electrophilic phenylselenenylating agent.[1,2] Ammonium peroxydisulfate also reacts with phenyl alkyl selenides to effect deselenenylation reactions from which phenylselenenyl sulfate is regenerated. Thus, several useful conversions of unsaturated compounds have been realized with a multistep, one-pot procedure which requires only catalytic amounts of diphenyl diselenide.[3]

We now report that ammonium peroxydisulfate also reacts with bis(4-methoxyphenyl) disulfide to produce an electrophilic sulfenylating agent which easily reacts with alkenes. Addition products are obtained when the reaction is carried out in the presence of either external or internal nucleophiles.

Scheme I



Scheme II



Results and Discussion

Preliminary experiments were carried out with several disulfides and unsaturated alcohols or acids in refluxing acetonitrile. With alkyl disulfides and with diphenyl disulfide no products of sulfur induced etherification or lactonization could be obtained; the starting disulfides were recovered, and ammonium peroxydisulfate effected the oxidation of the alkene. On the other hand, the same reactions carried out with bis(2,4-dimethoxyphenyl) disulfide gave exclusively rise to the oxidation of the disulfide to the corresponding thiosulfonate. Only with the bis(4-methoxyphenyl) disulfide the formation of the arylthio etherification or lactonization products could be observed, and therefore only this disulfide was employed to effect the reactions described below.

The reaction of ammonium peroxydisulfate with bis(4-methoxyphenyl) disulfide very likely proceeds in a way similar to that proposed for the corresponding reaction with diphenyl diselenide.[3] Thus, the interaction of the disulfide with the peroxydisulfate anions (either an electron transfer or an S_N2 process) is proposed to afford the (4-methoxyphenyl)sulfenyl sulfate. This is the reactive species which attacks the carbon carbon double bond to give a thiiranium intermediate which in the presence of a nucleophile affords the addition product (Scheme I).

Experiments, in which external oxygen nucleophiles were employed, were carried out by running the reactions in methanol or in acetonitrile and water. Unsatisfactory results were obtained in these cases, the products of arylthio methoxylation or hydroxylation of the various alkenes investigated being formed in poor yield. Better results were obtained in the reactions of arylthio amidation of alkenes which were carried out under experimental conditions identical to those already described for the phenylseleno amidation reactions,[4,5] i.e., in acetonitrile and

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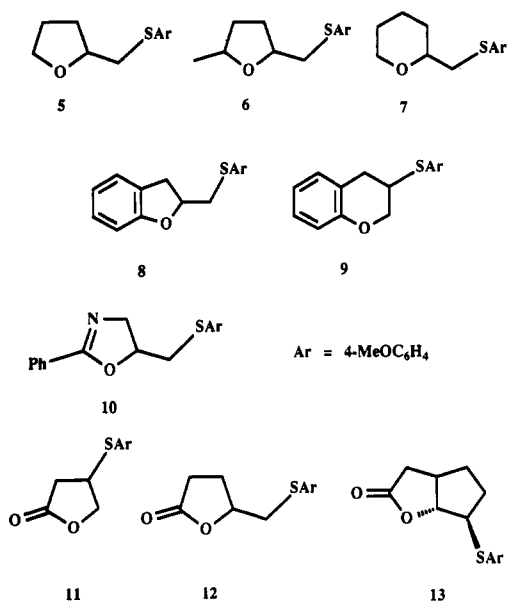
0022-3263/92/1957-4025$03.00/0 © 1992 American Chemical Society

Chart I



water in the presence of trifluoromethane sulfonic acid. Thus, styrene, 1-octene, (*E*)-3-hexene, and cyclohexene gave the products **1** (55%), **2** (56%), **3** (48%), and **4** (59%), respectively, after 24 h at 60 °C. These reactions very likely proceed as indicated in Scheme II.

The results obtained indicate that, under the conditions employed, this reaction is regiospecific, a single isomer being obtained from styrene and 1-octene. Moreover, the formation of compounds **3** and **4** from (*E*)-3-hexene and cyclohexene, respectively, indicate that, in agreement with the proposed mechanism, this reaction is a stereospecific trans addition.[6]

Experiments were then carried out starting from alkenes containing an internal nucleophile which can intramolecularly effect the trapping of the thiiranium intermediate and give ring-closure reactions. Because of their availability oxygen nucleophiles were employed in these experiments. The reactions were carried out in acetonitrile at 60 °C, with the unsaturated alcohols and acids previously employed for the corresponding reactions initiated by the phenylselenenyl sulfate.[2] Whereas the intermolecular versions of these reactions did not give any appreciable results, these intramolecular processes occurred easily to give the products of arylthio etherification and arylthio lactonization.

From the reactions of 4-penten-1-ol and 5-hexen-2-ol, the tetrahydrofuran derivatives **5** and **6** were obtained in 65% and 46% yield, respectively. As indicated by the NMR spectrum and by GLC–MS, the latter was a 1:1 mixture of two stereoisomers which could not be separated by column chromatography. From 5-hexen-1-ol the tetrahydropyran derivative **7** was formed in 56% yield. 2-Allylphenol instead gave a mixture (45%) of the two isomeric compounds **8** and **9**, in a 1:1 ratio, derived from both exo and endo cyclization. In this case the two compounds also could not be separated. Under the same conditions, allylbenzamide gave the dihydrooxazole **10** in excellent yield (95%) (Chart I).

Arylthio lactonization products were obtained from unsaturated acids. As in the case of the reaction with selenium electrophiles,[2] 3-butenoic acid gave the expected product **11** in low yield (31%). 4-Pentenoic acid instead afforded **12** in 84% yield, and 2-cyclopentene-1-acetic acid gave the bicyclic lactone **13** in 51% yield.

In all the reactions described above small amounts of the thiosulfonate $ArSO_2SAr$ were also isolated.

Several methods to effect arylthio etherifications and arylthio lactonizations have been described in the literature. Thus, methylbis(methylthio)sulfonium salts,[7] phenylsulfenyl chloride in the presence of *N,N*-diisopropylethylamine,[8] and (phenylthio)morpholine in the presence of trifluoromethane sulfonic acid[9] have all been employed as synthetically useful reagents. In other cases the sulfur-centered electrophilic species was produced from disulfides by chemical oxidation with Mn(III) acetate[10] or by electrochemical oxidation, either directly[11,12] or in the presence of bromide ions.[12] The presently described procedure can serve as a useful alternative to previous methods with several advantages due to the fact that the reagents employed are easily available and the operative conditions are extremely simple. The peroxydisulfate anion oxidation of disulfides to sulfenyl sulfates is limited to the case of the bis(4-methoxyphenyl) disulfide. However, this is not a too severe restriction of this method if one considers that in most cases the ArS group is introduced into the organic molecule in order to activate the α-carbon to further functionalization and it is eventually removed by oxidative or reductive cleavage.

Experimental Section

Bis(4-methoxyphenyl) disulfide[12] was prepared as described in the literature. All starting compounds were commercially available and were used without further purification. Reaction products were identified by proton and carbon-13 NMR spectroscopy, mass spectrometry, and elemental analyses.[13]

The arylthio amidation reactions were carried out according to the following general procedure. A mixture of alkene (3.5 mmol), disulfide (4.2 mmol), and ammonium peroxydisulfate (4.2 mmol) in $MeCN/H_2O$ (5:1) (10 mL), in the presence of trifluoromethane sulfonic acid (7.0 mmol), was stirred at 60 °C for 24 h. The progress of the reaction was monitored by TLC, GLC–MS, and NMR. The reaction mixture was poured into water and extracted with chloroform. The organic layer was washed with water, dried (Na_2SO_4), and evaporated. The reaction products were obtained in pure form after column chromatography on silica gel with chloroform or mixtures of petroleum ether and ether (from 90:10 to 60:40) as eluants.

The arylthio etherification and lactonization reactions were carried out according to the same procedure except that MeCN (10 mL) was used as solvent and trifluoromethane sulfonic acid was not added. Reaction times varied from 7 to 24 h.

Reaction yields are reported in the Results and Discussion. Physical and spectral data of reaction products are reported below.

1-Acetamido-1-phenyl-2-[(4-methoxyphenyl)thio]ethane (1): mp 85–88 °C; ^{1}H NMR δ 7.35 and 6.8 (AA′BB′, 4 H), 7.35–7.0 (m, 5 H), 6.05 (d, 1 H, J = 7.0 Hz), 5.09 (q, 1 H, J = 7.0 Hz), 3.8

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(6) The stereochemistry of the compounds **3** and **4** was assigned by means of the vicinal hydrogen coupling constant, determined by spin decoupling technique (see also ref 11).

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(s, 3 H), 3.3–3.1 (m, 2 H), 2.0 (s, 3 H); ^{13}C NMR δ 169.6, 158.9, 140.8, 133.3, 132.8, 128.2, 127.2, 126.4, 126.0, 114.5, 54.9, 52.8, 41.6, 22.7; MS *m/z* (relative intensity) 301 (4), 244 (2), 243 (7), 242 (42), 197 (3), 162 (5), 148 (25), 106 (100), 43 (10). Anal. Calcd for $C_{17}H_{19}NO_2S$: C, 67.75; H, 6.35; N, 4.65. Found: C, 67.61; H, 6.41; N, 4.70.

2-Acetamido-1-[(4-methoxyphenyl)thio]octane (2): mp 83–85 °C; ^{1}H NMR δ 7.32 and 6.75 (AA′BB′, 4 H), 5.9 (d, 1 H, *J* = 9.0 Hz), 4.1–3.9 (m, 1 H), 3.7 (s, 3 H), 2.9 (d, 2 H, *J* = 5.5 Hz), 1.7 (s, 3 H), 1.6–1.0 (m, 10 H), 0.8 (t, 3 H, *J* = 7.0 Hz); ^{13}C NMR δ 169.4, 158.9, 132.9, 126.5, 114.6, 55.1, 49.0, 40.5, 33.4, 31.5, 28.9, 25.7, 23.0, 22.4, 13.8; MS *m/z* (relative intensity) 309 (9), 252 (4), 251 (12), 250 (69), 170 (28), 142 (3), 141 (6), 140 (46), 139 (30), 114 (100), 43 (39). Anal. Calcd for $C_{17}H_{27}NO_2S$: C, 65.98; H, 8.79; N, 4.53. Found: C, 66.06; H, 8.70; N, 4.49.

3-Acetamido-4-[(4-methoxyphenyl)thio]hexane (3): mp 56–58 °C; ^{1}H NMR δ 7.38 and 6.82 (AA′BB′, 4 H), 5.63 (d, 1 H, *J* = 9.1 Hz), 4.1 (ddt, 1 H, *J* = 3.5, 9.1, and 9.9 Hz), 3.8 (s, 3 H), 3.05 (ddd, 1 H, *J* = 3.5, 6.1, and 8.4 Hz), 1.71 (s, 3 H), 1.8–1.3 (m, 4 H), 1.07 (t, 3 H, *J* = 7.2 Hz), 0.9 (t, 3 H, *J* = 7.2 Hz); ^{13}C NMR δ 169.5, 159.2, 134.1, 126.8, 114.7, 58.9, 55.2, 53.8, 26.3, 23.1, 22.7, 12.3, 10.7; MS *m/z* (relative intensity) 281 (9), 224 (4), 223 (10), 222 (68), 182 (11), 181 (15), 142 (15), 141 (4), 140 (16), 139 (74), 100 (39), 58 (100), 43 (17). Anal. Calcd for $C_{15}H_{23}NO_2S$: C, 64.02; H, 8.24; N, 4.98. Found: C, 64.11; H, 8.31; N, 5.04.

1-Acetamido-2-[(4-methoxyphenyl)thio]cyclohexane (4): mp 131–134 °C; ^{1}H NMR δ 7.4 and 6.85 (AA′BB′, 4 H), 5.76 (d, 1 H, *J* = 7.6 Hz), 3.74 (s, 3 H), 3.61 (ddt, 1 H, *J* = 4.0, 7.6, and 10.4 Hz), 2.64 (dt, 1 H, *J* = 3.6 and 10.4 Hz), 2.25–1.95 (m, 2 H), 2.0 (s, 3 H), 1.8–1.6 (m, 2 H), 1.5–1.2 (m, 4 H); ^{13}C NMR δ 169.3, 159.8, 136.4, 123.1, 114.5, 55.2, 52.5, 52.2, 33.6, 33.0, 25.9, 24.5, 23.5; MS *m/z* (relative intensity) 280 (1), 279 (9), 225 (5), 221 (15), 220 (100), 140 (40), 139 (14), 98 (29), 81 (26), 43 (18). Anal. Calcd for $C_{15}H_{21}NO_2S$: C, 64.49; H, 7.58; N, 5.01. Found: C, 64.38; H, 7.52; N, 4.96.

2-[[(4-Methoxyphenyl)thio]methyl]tetrahydrofuran (5):[12] oil; ^{1}H NMR δ 7.38 and 6.8 (AA′BB′, 4 H), 3.95 (quintet, 1 H, *J* = 6.4 Hz), 3.92–3.65 (m, 2 H), 3.75 (s, 3 H), 3.04 (dd, 1 H, *J* = 5.8 and 13.0 Hz), 2.83 (dd, 1 H, *J* = 6.8 and 13.0 Hz), 2.1–1.8 (m, 3 H), 1.7–1.5 (m, 1 H); ^{13}C NMR δ 158.8, 133.0, 126.5, 114.5, 77.8, 68.0, 55.1, 40.9, 30.8, 25.7; MS *m/z* (relative intensity) 226 (2), 225 (5), 224 (39), 154 (17), 139 (12), 71 (100), 43 (22).

2-Methyl-5-[[(4-methoxyphenyl)thio]methyl]tetrahydrofuran (6): oil; ^{1}H NMR (from the spectrum of the mixture the absorptions due to the two isomers could be distinguished with the help of decoupling experiments) δ 7.38 and 6.72 (AA′BB′, 4 H), 4.2–4.05 (m, 2 H), 3.8 (s, 3 H), 3.05 (dd, 1 H, *J* = 5.5 and 13.0 Hz), 2.81 (dd, 1 H, *J* = 7.3 and 13.0 Hz), 2.2–1.8 (m, 2 H), 1.6–1.3 (m, 2 H), 1.19 (d, 3 H, *J* = 6.2 Hz); δ 7.38 and 6.72 (AA′BB′, 4 H), 4.05–3.9 (m, 2 H), 3.8 (s, 3 H), 3.07 (dd, 1 H, *J* = 5.4 and 13.1 Hz), 2.84 (dd, 1 H, *J* = 7.2 and 13.1 Hz), 2.2–1.8 (m, 2 H), 1.8–1.6 (m, 2 H), 1.23 (d, 3 H, *J* = 6.1 Hz); ^{13}C NMR δ 158.8, 132.9, 132.6, 126.6, 114.5, 78.0, 77.3, 75.8, 75.1, 55.2, 41.3, 33.7, 32.8, 31.6, 30.8, 21.3, 21.1; MS *m/z* (relative intensity) 238 (1), 173 (45), 172 (65), 157 (6), 156 (17), 155 (100), 123 (41), 108 (31), 83 (24), 82 (27), 55 (82); 238 (1), 173 (47), 172 (65), 157 (5), 156 (15), 155 (100), 123 (39), 108 (31), 83 (24), 82 (27), 55 (81). Anal. Calcd for $C_{13}H_{18}O_2S$: C, 65.51; H, 7.61. Found: C, 65.55; H, 7.57.

2-[[(4-Methoxyphenyl)thio]methyl]tetrahydro-2*H*-pyran (7):[12] oil; ^{1}H NMR δ 7.32 and 6.78 (AA′BB′, 4 H), 4.05–3.9 (m, 1 H), 3.75 (s, 3 H), 3.5–3.25 (m, 2 H), 2.95 (dd, 1 H, *J* = 6.5 and 13.1 Hz), 2.78 (dd, 1 H, *J* = 5.9 and 13.1 Hz), 1.9–1.1 (m, 6 H); ^{13}C NMR δ 153.7, 127.7, 122.0, 109.4, 71.4, 63.3, 50.0, 36.6, 26.0, 20.8, 18.2; MS *m/z* (relative intensity) 240 (2), 239 (6), 238 (37), 154 (22), 139 (12), 85 (100), 67 (14), 57 (12), 43 (15).

2-[[(4-Methoxyphenyl)thio]methyl]-2,3-dihydrobenzofuran (8) and 3-[(4-methoxyphenyl)thio]-2,3-dihydrobenzopyran (9): oil; ^{1}H NMR δ 7.7–7.55 (m, 4 H), 7.2–6.7 (m, 12 H), 5.4–5.2 (m, 1 H), 4.95–4.8 (m, 1 H), 3.9 (s, 6 H), 3.55–2.85 (m, 8 H); ^{13}C NMR δ 128.4, 128.3, 126.2, 125.8, 125.0, 121.0, 115.0, 109.9, 109.0, 96.2, 77.2, 76.6, 64.5, 62.4, 55.5, 35.6, 35.3; MS *m/z* (relative intensity) 272 (100), 154 (54), 140 (87), 139 (70), 133 (76), 131 (70), 119 (58), 105 (29), 91 (49), 77 (35), 44 (69); 272 (94), 156 (96), 155 (65), 154 (61), 153 (67), 139 (83), 133 (100), 131 (72), 119 (63), 105 (30), 91 (47), 77 (40), 44 (57). Anal. Calcd for $C_{16}H_{16}O_2S$: C, 70.56; H, 5.92. Found: C, 70.48; H, 5.89.

2-Phenyl-5-[[(4-methoxyphenyl)thio]methyl]-4,5-dihydrooxazole (10): oil; ^{1}H NMR δ 7.84 and 6.8 (AA′BB′, 4 H), 7.5–7.3 (m, 5 H), 4.77 (ddt, 1 H, *J* = 5.5, 7.0, and 9.4 Hz), 4.12 (dd, 1 H, *J* = 9.4 and 15.0 Hz), 3.83 (dd, 1 H, *J* = 6.9 and 15.0 Hz), 3.76 (s, 3 H), 3.18 (dd, 1 H, *J* = 5.5 and 13.7 Hz), 2.94 (dd, 1 H, *J* = 7.1 and 13.7 Hz); ^{13}C NMR δ 163.6, 159.4, 134.0, 131.1, 128.1, 127.7, 125.1, 114.7, 78.4, 59.5, 55.2, 40.3; MS *m/z* (relative intensity) 301 (6), 300 (19), 299 (94), 146 (100), 130 (68), 118 (46), 105 (79), 91 (67), 77 (63). Anal. Calcd for $C_{17}H_{17}NO_2S$: C, 68.20; H, 5.72; N, 4.68. Found: C, 68.25; H, 5.78; N, 4.62.

4-[(4-Methoxyphenyl)thio]tetrahydrofuran-2-one (11): oil; ^{1}H NMR δ 7.4 and 6.88 (AA′BB′, 4 H), 4.48 (dd, 1 H, *J* = 6.7 and 9.8 Hz), 4.18 (dd, 1 H, *J* = 5.5 and 9.8 Hz), 3.9–3.75 (m, 1 H), 3.82 (s, 3 H), 2.84 (dd, 1 H, *J* = 8.0 and 17.9 Hz), 2.48 (dd, 1 H, *J* = 6.4 and 17.9 Hz); ^{13}C NMR δ 174.7, 160.6, 136.3, 122.0, 115.1, 96.2, 72.4, 55.4, 42.6, 34.9; MS *m/z* (relative intensity) 226 (6), 225 (13), 224 (100), 166 (7), 142 (3), 141 (10), 140 (69), 139 (97), 125 (32), 96 (10), 85 (9), 45 (7). Anal. Calcd for $C_{11}H_{12}O_3S$: C, 58.91; H, 5.39. Found: C, 59.03; H, 5.34.

5-[[(4-Methoxyphenyl)thio]methyl]tetrahydrofuran-2-one (12):[12] oil; ^{1}H NMR δ 7.4 and 6.85 (AA′BB′, 4 H), 4.65–4.48 (m, 1 H), 3.8 (s, 3 H), 3.25 (dd, 1 H, *J* = 4.9 and 13.8 Hz), 2.95 (dd, 1 H, *J* = 7.7 and 13.8 Hz), 2.6–2.25 (m, 3 H), 2.1–1.9 (m, 1 H); ^{13}C NMR δ 176.2, 159.7, 134.0, 125.0, 114.9, 78.7, 55.3, 40.6, 28.4, 26.9; MS *m/z* (relative intensity) 240 (6), 239 (13), 238 (96), 155 (5), 154 (14), 153 (100), 139 (22), 138 (22), 109 (19), 85 (35), 45 (12).

8-[(4-Methoxyphenyl)thio]-2-oxabicyclo[3.3.0]octan-3-one (13): oil; ^{1}H NMR δ 7.4 and 6.83 (AA′BB′, 4 H), 4.76 (d, 1 H, *J* = 6.5 Hz), 3.8 (s, 3 H), 3.72–3.63 (m, 1 H), 3.2–3.0 (m, 1 H), 2.8 (dd, 1 H, *J* = 9.9 and 18.3 Hz), 2.3 (dd, 1 H, *J* = 2.5 and 18.3 Hz), 2.35–2.0 (m, 2 H), 1.85–1.65 (m, 1 H), 1.65–1.45 (m, 1 H); ^{13}C NMR δ 176.5, 159.6, 134.3, 124.2, 114.8, 89.5, 55.2, 52.9, 37.1, 35.6, 31.9, 29.8; MS *m/z* (relative intensity) 266 (5), 265 (15), 264 (100), 142 (4), 141 (9), 140 (90), 139 (36), 125 (28), 41 (12). Anal. Calcd for $C_{14}H_{16}O_3S$: C, 63.62; H, 6.10. Found: C, 63.57; H, 6.16.

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Registry No. 1, 141248-72-8; 2, 141248-73-9; 3, 141248-74-0; 4, 141248-75-1; 5, 111017-45-9; 6, 141248-76-2; 7, 111017-46-0; 8, 111017-50-6; 9, 141248-77-3; 10, 141248-78-4; 11, 141248-79-5; 12, 111017-49-3; 13, 141248-80-8; bis(4-methoxyphenyl) disulfide, 5335-87-5; ammonium peroxydisulfate, 7727-54-0; styrene, 100-42-5; 1-octene, 111-66-0; (*E*)-3-hexene, 13269-52-8; cyclohexene, 110-83-8; 4-penten-1-ol, 821-09-0; 5-hexen-2-ol, 626-94-8; 5-hexen-1-ol, 821-41-0; 2-allylphenol, 1745-81-9; allylbenzamide, 10283-95-1; 3-butenoic acid, 625-38-7; 4-pentenoic acid, 591-80-0; 2-cyclopentene-1-acetic acid, 13668-61-6.

A Facile and General Synthesis of 3-(Acyloxy)cephalosporins

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The ease of isomerization of the cephem double bond has been a significant hindrance to the chemical modification of cephalosporin antibiotics. A facile base-catalyzed double-bond isomerization occurs when the 4-carboxylic acid is esterified or otherwise blocked (e.g., as the mixed anhydride or chloride).[1-3] Since purification of these Δ^2/Δ^3

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