SUPPORTING INFORMATION

Efficient and mild Swern oxidation using a new sulfoxide and *bis*(trichloromethyl)carbonate

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Table of Contents:

Typical procedure.....	S2-S4
Characterization data.....	S2-S9
¹ H NMR, ¹³ C NMR, LRMS, HRMS of I, II, III, IV	S10-S17
¹ H NMR, LRMS of V	S18
¹ H NMR, ¹³ C NMR of aldehydes and ketones	S19-S26

Typical procedure for the preparation of I:

A solution of **IV** (5.0 g, 18.5 mmol) in EtOH (10 mL) was stirred, and a 20% solution of CH₃SNa in water (9.07 g, 25.9 mmol) was added dropwise over 0.5 h at rt. The flask was heated to 60°C and the reaction was monitored by TLC until completed. A 30% solution of H₂O₂ (3.15 g, 27.8 mmol) was added dropwise over 0.5 h at rt. and then the reaction mixture was heated to 30°C in an O₂ atmosphere. After stirring for 1h, the reaction was completed. EtOH was recovered by vacuum distillation, the mixture was extracted with EtOAc (15 mL x 2), decanted, and washed with brine. After drying over Na₂SO₄ and concentration, the crude was purified by flash chromatography (SiO₂; CH₂Cl₂). 4-(2-(2-(methylsulfinyl)ethyl)-4-nitrophenyl)-morpholine **I** was acquired, an orange red liquid (4.20 g, 76%).

I: ¹H NMR (400 MHz, CDCl₃): δ 7.99 (dd, *J*₁ 8.8 Hz, *J*₂ 2.0 Hz, 1H), 7.84 (m, 1H), 6.27 (d, *J* 8.8 Hz, 1H), 3.94 – 3.84 (m, 2H), 3.79 – 3.66 (m, 4H), 3.51 – 3.38 (m, 2H), 3.07 (t, *J* 8.4 Hz, 2H), 2.97 – 2.80 (m, 2H), 2.58 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 156.8, 137.7, 129.5, 126.3, 120.5, 103.3, 68.8, 63.6, 54.8, 53.0, 46.9, 39.3, 27.2. LRMS (ESI⁺): *m/z* 299.3 [M+H]⁺, 321.3 [M+Na]⁺. HRMS (ESI): calcd. for C₁₃H₁₈N₂O₄S[M+Na]⁺ 321.0893; found 321.0879.

Typical Procedure for the oxidation of alcohols:

A solution of BTC (0.41 g, 1.39 mmol) in dry CH₂Cl₂ (5 mL) was cooled in ice salt bath under an atmosphere of N₂. A solution of **I** (1.24 g, 4.17 mmol) in dry CH₂Cl₂ (5 mL) was added dropwise over 0.5 h at -15°C. Stirring was continued for 0.5h, a

solution of benzyl alcohol (0.3 g, 2.78 mmol) in dry CH_2Cl_2 (5 mL) was added dropwise over 0.5 h at -15°C . After stirring for 0.5 h, Et_3N (0.84 g, 8.34 mmol) was added slowly while the temperature should be controlled below -15°C . When the reaction was completed, 10% HCl solution in water was added dropwise until the pH of the reaction solution reached 2 under ice bath. The mixture was extracted with n-hexane or petroleum ether (10 mL x 2), decanted. The product was acquired after organic layer was concentrate and purified by flash chromatography (SiO_2 ; n-hexane). (0.27 g, 92%) The water layer was used for the recovery of **V** and the excess **I**.

Typical Procedure for the recovery and re-oxidized of co-product 4-(2-(2-(methylthio)ethyl)- 4-nitrophenyl)morpholine **V :**

A solution of 25% NaOH in water was added dropwise in the water layer from the oxidation procedure until the pH reached 12. The mixture was extracted with CH_2Cl_2 (15 mL x 2), decanted, and washed with brine. The co-product 4-(2-(2-(methylthio)-ethyl)-4-nitrophenyl)-morpholine **V** was recovered after concentration (90%). Treated **V** with a 30% solution of H_2O_2 in water at r.t. and then the reaction mixture was heated to 30°C in an O_2 atmosphere. After stirring for 1 h, the reaction was completed. EtOH was recovered by vacuum distillation, the mixture was extracted with EtOAc (15 mL x 2), decanted, and washed with brine. After drying over Na_2SO_4 and concentration, the crude was purified by flash chromatography (SiO_2 ; CH_2Cl_2), (94%).

V: ^1H NMR (400 MHz, CDCl_3): δ 7.98 (dd, J_1 8.8 Hz, J_2 2.4 Hz, 1H), 7.82 (d, J 2.4

Hz, 1H), 6.26 (d, *J* 8.8 Hz, 1H), 3.76 (t, *J* 8.4 Hz, 2H), 3.69 – 3.60 (m, 4H), 3.43 (t, *J* 5.2 Hz, 2H), 3.06 (t, *J* 8.4 Hz, 2H), 2.65 (t, *J* 6.4 Hz, 2H), 2.11 (s, 3H). LRMS (ESI⁺): *m/z* 283.0 [M+H]⁺.

Typical Procedure for the reuse of I: The procedure was the same as the typical procedure for the oxidation of alcohols. The yield of benzaldehyde was 90%.

Typical procedure for the preparation of III and IV:

(1) A mixture of 2-(2-chloro-5-nitrophenyl)ethanol **II** (5.0 g, 24.8 mmol) and morpholine (10.8 g, 124 mmol) was stirred and heated to 120°C for 5h, the reaction was monitored by TLC. The excess morpholine was recovered by vacuum distillation, and then water (25 mL) was added, then the mixture was filtered and washed with water to afford a yellow solid, 2-(2-morpholino-5-nitrophenyl)ethanol **III** (6.21 g, 99%), (m.p. 150.8°C-151.5°C).

(2) A mixture of **III** (5.00 g, 19.8 mmol) and chlorobenzene (20 mL) was heated to 100°C, then a solution of BTC (2.16 g, 7.27 mmol) in chlorobenzene (5 mL) was added dropwise over 0.5 h. The reaction was monitored by TLC until completed. Chlorobenzene was recovered by vacuum distillation and the residue was quenched with water (15 mL), and extracted with CH₂Cl₂ (15 mL x 2), decanted, and washed with brine. The organic phase was concentrated under vacuum to afford brownish red liquid 4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine **IV** (5.30 g, 99%).

(2-(methylsulfinyl)ethyl)benzene: a yellow liquid(2.18 g, 100%). ^1H NMR (400 MHz, CDCl_3): δ 7.33 – 7.23 (m, 5H), 3.17 – 3.04 (m, 2H), 3.03 – 2.90 (m, 2H), 2.59 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ = 138.6, 128.8(2C), 128.5(2C), 126.8, 56.1, 38.7, 29.0. LRMS (ESI $^+$): m/z 169.1[M+H] $^+$. HRMS(ESI): calcd. for $\text{C}_9\text{H}_{12}\text{OS}[\text{M}+\text{Na}]^+$ 191.0501; found 191.0496.

2-(2-morpholino-5-nitrophenyl)ethanol III: a yellow solid(6.21 g, 99%); m.p. 149-150°C. ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 8.15 (d, J 2.8 Hz, 1H), 8.03 (dd, J_I 8.8 Hz, J_2 2.8 Hz, 1H), 7.19 (d, J 8.8 Hz, 1H), 4.81 (t, J 5.2 Hz, 1H), 3.81 – 3.67 (m, 6H), 3.03 – 2.91 (m, 4H), 2.85 (t, J 6.4 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ 157.2, 142.0, 134.6, 124.8, 122.3, 119.3, 66.2(2C), 60.3, 51.9(2C), 33.4 ppm. LRMS (ESI $^+$): m/z 253.1[M+H] $^+$. HRMS(ESI): calcd. for $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_4$ [M+Na] $^+$ 275.1002; found 275.1008.

4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine IV: a brownish red liquid(5.30 g, 99%), ^1H NMR (400 MHz, CDCl_3): δ 8.02 (dd, J_I 8.8 Hz, J_2 2.4 Hz, 1H), 7.86 (d, J 2.4 Hz, 1H), 6.29 (d, J 8.8 Hz, 1H), 3.79 (t, J 8.4 Hz, 2H), 3.75-3.71 (m, 4H), 3.61 (t, J 5.6 Hz, 2H), 3.46 (t, J 5.6 Hz, 2H), 3.09 (t, J 8.4 Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 156.9, 137.8, 129.7, 126.6, 120.7, 103.4, 71.4, 69.0, 53.4, 47.1, 43.1, 27.4. LRMS (ESI $^+$): m/z 271.1 [M+H] $^+$. HRMS(ESI): calcd. for $\text{C}_{12}\text{H}_{15}\text{ClN}_2\text{O}_3$ [M+Na] $^+$ 293.0663; found 293.0666.

4-(2-(2-(methylsulfinyl)ethyl)-4-nitrophenyl)morpholine I: an orange red liquid(4.20 g, 76.0%). ^1H NMR (400 MHz, CDCl_3): δ 7.99 (dd, J_I 8.8 Hz, J_2 2.0 Hz, 1H), 7.84 (m, 1H), 6.27 (d, J 8.8 Hz, 1H), 3.94 – 3.84 (m, 2H), 3.79 – 3.66 (m, 4H),

3.51 – 3.38 (m, 2H), 3.07 (t, *J* 8.4 Hz, 2H), 2.97 – 2.80 (m, 2H), 2.58 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 156.8, 137.7, 129.5, 126.3, 120.5, 103.3, 68.8, 63.6, 54.8, 53.0, 46.9, 39.3, 27.2. LRMS (ESI⁺): *m/z* 299.3 [M+H]⁺, 321.3 [M+Na]⁺. HRMS(ESI): calcd. for C₁₃H₁₈N₂O₄S[M+Na]⁺ 321.0893; found 321.0879.

4-(2-(2-(methylthio)-ethyl)-4-nitrophenyl)morpholine V: an orange liquid. ¹H NMR (400 MHz, CDCl₃): δ 7.98 (dd, *J*₁ 8.8 Hz, *J*₂ 2.4 Hz, 1H), 7.82 (d, *J* 2.4 Hz, 1H), 6.26 (d, *J* 8.8 Hz, 1H), 3.76 (t, *J* 8.4 Hz, 2H), 3.69 – 3.60 (m, 4H), 3.43 (t, *J* 5.2 Hz, 2H), 3.06 (t, *J* 8.4 Hz, 2H), 2.65 (t, *J* 6.4 Hz, 2H), 2.11 (s, 3H). LRMS (ESI⁺): *m/z* 283.0 [M+H]⁺.

Benzaldehyde: (242 mg, 91.4 % yield); liquid (commercially available, liquid). ¹H NMR (400 MHz, CDCl₃): δ 10.01 (s, 1H), 7.91-7.85 (m, 2H), 7.66-7.57 (m, 1H), 7.56-7.44 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 192.2, 136.4, 134.4, 129.7(2C), 129.0(2C).

4-Methylbenzaldehyde: (245 mg, 81.6% yield); liquid (commercially available, liquid). ¹H NMR (400 MHz, CDCl₃): δ 9.94 (s, 1H), 7.77 (d, *J* 8.0 Hz, 2H), 7.32 (d, *J* 8.0 Hz, 2H), 2.45 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 191.7, 145.5, 134.3, 129.8(2C), 129.7(2C), 22.1.

4-Methoxybenzaldehyde: (274 mg, 80.5% yield); liquid (commercially available, liquid). ¹H NMR (400 MHz, CDCl₃): δ 9.88 (s, 1H), 7.84 (d, *J* 8.8 Hz, 2H), 7.01 (d, *J* 8.8 Hz, 2H), 3.90 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 190.5, 164.5, 131.9(2C), 129.4, 114.4(2C), 55.8.

2-Cholorbenzaldehyde: (326 mg, 92.7% yield); liquid (commercially avaiable, liquid). ^1H NMR (400 MHz, CDCl_3): δ 10.48 (s, 1H), 7.92 (dd, J_1 7.6 Hz, J_2 1.6 Hz, 1H), 7.56-7.50 (m, 1H), 7.46 (dd, J_1 8.0 Hz, J_2 1.2 Hz, 1H), 7.42-7.37 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3): δ 189.6, 137.9, 135.1, 133.3, 130.6, 129.4, 127.3.

2-Nitrobenzaldehyde: (289 mg, 76.6% yield); m.p. 42-43°C (commercially avaiable, m.p. 43-44 °C). ^1H NMR (400 MHz, CDCl_3): δ 10.42 (s, 1H), 8.12 (dd, J_1 7.6 Hz, J_2 1.2 Hz, 1H), 7.96 (dd, J_1 7.6 Hz, J_2 1.6 Hz, 1H), 7.83 – 7.73 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 187.9, 149.6, 134.0, 133.7, 131.3, 129.6, 124.5.

Methyl 4-formylbenzoate: (314 mg, 76.5% yield); m.p. 55-57 °C (commercially avaiable, m.p. 59-63 °C). ^1H NMR (400 MHz, CDCl_3): δ 10.09 (s, 1H), 8.22-8.13 (m, 2H), 8.08-7.91 (m, 2H), 3.97 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 191.4, 166.0, 139.1, 135.0, 130.2(2C), 129.5(2C), 52.7.

Terephthalaldehyde: (236 mg, 70.4% yield); m.p. 112-113 °C (commercially avaiable, m.p. 114-116 °C). ^1H NMR (400 MHz, CDCl_3): δ 10.13 (s, 2H), 8.06 (s, 4H). ^{13}C NMR (100 MHz, CDCl_3): δ 191.3(2C), 140.0(2C), 130.2(4C).

1-Naphthaldehyde: (267 mg, 68.5% yield); liquid (commercially avaiable, liquid). ^1H NMR (400 MHz, CDCl_3): δ 10.40 (s, 1H), 9.26 (d, J 8.8 Hz, 1H), 8.11 (d, J 8.4 Hz, 1H), 8.00 (dd, J_1 7.2, J_2 1.6 Hz, 1H), 7.93 (d, J 8.0 Hz, 1H), 7.73-7.68 (m, 1H), 7.66-7.58 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 193.3, 136.5, 135.2, 133.8, 131.5, 130.6, 129.0, 128.5, 127.0, 125.8, 124.9.

Acetophenone: (276 mg, 92.1% yield); liquid (commercially avaiable, liquid). ^1H NMR (400 MHz, CDCl_3): δ 7.99-7.94 (m, 2H), 7.59-7.54 (m, 1H), 7.49-7.44 (m, 2H),

7.38-7.29 (m, 1H), 2.62 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 198.0, 137.0, 132.9, 128.3(2C), 128.2(2C), 26.9.

1-(P-tolyl)ethanone: (270 mg, 80.5% yield); liquid (commercially available, liquid).

^1H NMR (400 MHz, CDCl_3): δ 7.86 (d, J 8.4 Hz, 2H), 7.25 (d, J 7.6 Hz, 2H), 2.59 (s, 3H), 2.42 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 197.5, 143.7, 134.7, 129.2(2C), 128.4(2C), 26.7, 21.8.

Benzophenone: (367 mg, 79.7% yield); m.p. 47-48°C (commercially available, m.p.

47-49°C). ^1H NMR (400 MHz, CDCl_3): δ 7.86-7.75 (m, 4H), 7.62-7.56 (m, 2H), 7.54-7.45 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3): δ 196.5, 137.6(2C), 132.3(2C), 130.0(4C), 128.2(4C).

1-(4-Fluorophenyl)ethanone: (253 mg, 73.4% yield); liquid (commercially available,

liquid). ^1H NMR (400 MHz, CDCl_3): δ 8.03-7.93 (m, 2H), 7.13 (t, J 8.8 Hz, 2H), 2.60 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 196.2, 166.9, 133.6, 131.0, 130.9, 115.8, 115.5, 26.7.

1-(3,5-bis(trifluoromethyl)phenyl)ethanone: (421 mg, 65.8% yield); liquid

(commercially available, liquid). ^1H NMR (400 MHz, CDCl_3): δ 8.38 (s, 2H), 8.07 (s, 1H), 2.72 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 194.7, 138.5, 132.6, 132.3, 128.3(2C), 126.3, 124.3, 121.6, 26.8.

1-(4-Nitrophenyl)ethanone: (302 mg, 73.3% yield); m.p. 73-75 °C (commercially

available, m.p. 75-78 °C). ^1H NMR (400 MHz, CDCl_3): δ 8.31 (d, J 9.0 Hz, 2H), 8.11 (d, J 9.0 Hz, 2H), 2.69 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3): δ 196.0, 150.3, 141.4, 129.3(2C), 123.9(2C), 27.2.

2,3-Dihydro-1H-inden-1-one: (261 mg, 79.0% yield); m.p. 33-35 °C (commercially available, m.p. 38-40 °C). ¹H NMR (400 MHz, CDCl₃): δ 7.76 (d, *J* 7.6 Hz, 1H), 7.59 (t, *J* 7.6 Hz, 1H), 7.48 (d, *J* 7.6 Hz, 1H), 7.37 (t, *J* 7.6 Hz, 1H), 3.16 (t, *J* 6.0Hz, 2H), 2.71 (t, *J* 6.0Hz, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 206.8, 155.0, 137.1, 134.5, 127.2, 126.7, 123.7, 36.4, 26.0.

2,7-Dibromo-9H-fluoren-9-one: (644 mg, 76.2% yield); m.p. 195-197°C (commercially available, m.p. 203-205°C). ¹H NMR (400 MHz, CDCl₃): δ 7.75 (d, *J* 1.6Hz, 1H), 7.62 (dd, *J*₁ 8.0 Hz, *J*₂ 2.0 Hz, 1H), 7.38 (d, *J* 8.0 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃): δ 190.7, 142.2(2C), 137.4(2C), 135.3(2C), 127.8(2C), 123.4(2C), 121.8(2C).

(3r,5r,7r)-Adamantane-1-carbaldehyde: (292 mg, 71.2% yield); m.p. 190-194 °C (commercially available, m.p. 189-198 °C). ¹H NMR (400 MHz, CDCl₃): δ 9.31 (s, 1H), 2.12-1.96 (m, 3H), 1.83-1.53 (m, 12H). ¹³C NMR (100 MHz, CDCl₃): δ 205.7, 39.3, 37.2, 36.9, 36.7, 36.2 (3C), 28.3, 28.1, 27.7.

¹H NMR spectrum of (2-(methylsulfinyl)ethyl)benzene

¹³C NMR spectrum of (2-(methylsulfinyl)ethyl)benzene

LRMS of (2-(methylsulfinyl)ethyl)benzene

HRMS of (2-(methylsulfinyl)ethyl)benzene

¹H NMR spectrum of 2-(2-morpholino-5-nitrophenyl)ethanol III

¹³C NMR spectrum of 2-(2-morpholino-5-nitrophenyl)ethanol III

LRMS of 2-(2-morpholino-5-nitrophenyl)ethanol III

HRMS of 2-(2-morpholino-5-nitrophenyl)ethanol III

¹H NMR spectrum of 4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine IV

¹³C NMR spectrum of 4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine IV

LRMS of 4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine IV

HRMS of 4-(2-(2-chloroethyl)-4-nitrophenyl)morpholine IV

¹H NMR spectrum of 4-(2-(2-(methylsulfinyl) ethyl)-4-nitrophenyl)morpholine (I)

¹³C NMR spectrum of 4-(2-(2-(methylsulfinyl)ethyl)-4-nitrophenyl)morpholine (I)

LRMS of 4-(2-(2-(methylsulfinyl) ethyl)-4-nitrophenyl)morpholine (I)

HRMS of 4-(2-(2-(methylsulfinyl) ethyl)-4-nitrophenyl)morpholine (I)

¹H NMR spectrum of 4-(2-(2-(methylthio)ethyl)nitrophenyl)morpholine (V)

LRMS of 4-(2-(2-(methylthio)ethyl)nitrophenyl)morpholine (V)

^1H NMR spectrum of **benzaldehyde** in CDCl_3 :

^{13}C NMR spectrum of **benzaldehyde** in CDCl_3 :

^1H NMR spectrum of **4-methylbenzaldehyde** in CDCl_3 :

^{13}C NMR spectrum of **4-methylbenzaldehyde** in CDCl_3 :

^1H NMR spectrum of **4-methoxybenzaldehyde** in CDCl_3 :

^{13}C NMR spectrum of **4-methoxybenzaldehyde** in CDCl_3 :

^1H NMR spectrum of **2-chlorobenzaldehyde** in CDCl_3 :

^{13}C NMR spectrum of **2-chlorobenzaldehyde** in CDCl_3 :

¹H NMR spectrum of **2-nitrobenzaldehyde** in CDCl₃:

¹³C NMR spectrum of **2-nitrobenzaldehyde** in CDCl₃:

^1H NMR spectrum of **methyl 4-formylbenzoate** in CDCl_3 :

^{13}C NMR spectrum of **methyl 4-formylbenzoate** in CDCl_3 :

¹H NMR spectrum of **terephthalaldehyde** in CDCl₃:

¹³C NMR spectrum of **terephthalaldehyde** in CDCl₃:

^1H NMR spectrum of **1-naphthaldehyde** in CDCl_3 :

^{13}C NMR spectrum of **1-naphthaldehyde** in CDCl_3 :

^1H NMR spectrum of **acetophenone** in CDCl_3 :

^{13}C NMR spectrum of **acetophenone** in CDCl_3 :

^1H NMR spectrum of **1-(*p*-tolyl)ethanone** in CDCl_3 :

^{13}C NMR spectrum of **1-(*p*-tolyl)ethanone** in CDCl_3 :

^1H NMR spectrum of **benzophenone** in CDCl_3 :

^{13}C NMR spectrum of **benzophenone** in CDCl_3 :

¹H NMR spectrum of **1-(4-fluorophenyl)ethanone** in CDCl₃:

¹³C NMR spectrum of **1-(4-fluorophenyl)ethanone** in CDCl₃:

¹H NMR spectrum of **1-(3,5-bis(trifluoromethyl)phenyl)ethanone** in CDCl₃:

¹³C NMR spectrum of **1-(3,5-bis(trifluoromethyl)phenyl)ethanone** in CDCl₃:

^1H NMR spectrum of **1-(4-nitrophenyl)ethanone** in CDCl_3 :

^{13}C NMR spectrum of **1-(4-nitrophenyl)ethanone** in CDCl_3 :

¹H NMR spectrum of **2,3-dihydro-1H-inden-1-one** in CDCl₃:

¹³C NMR spectrum of **2,3-dihydro-1H-inden-1-one** in CDCl₃:

¹H NMR spectrum of **2,7-dibromo-9H-fluoren-9-one** in CDCl₃:

¹³C NMR spectrum of **2,7-dibromo-9H-fluoren-9-one** in CDCl₃:

^1H NMR spectrum of the oxidation product of **4-phenylbutan-1-ol** in CDCl_3 :

^1H NMR spectrum of (3r,5r,7r)-adamantane-1-carbaldehyde in CDCl_3 :

^{13}C NMR spectrum of (3r,5r,7r)-adamantane-1-carbaldehyde in CDCl_3 :