

Cyclopropanation of [2,2']biadamantylidene with Me₃Al–CH₂I₂ reagent

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Experimental

The reagents were obtained from Sigma-Aldrich or Acros. Dichloromethane was distilled over P₂O₅. [2,2']Biadamantylidene was prepared from adamantanone by McMurry reaction.¹ Diethyl zinc was synthesized by the reaction of anhydrous ZnCl₂ with Et₃Al.² Diazomethane was prepared from *N*-methyl-*N*-nitrosourea.³ Chromatographic analysis was performed on a Shimadzu GC-9A instrument using a 2000×2 mm column, the SE-30 (5 %) stationary phase on Chromaton N-AW-HMDS (0.125-0.160 mm), helium carrier gas (30 mL/min), temperature programming from 50 to 300 °C at a 8 °C/min rate. Nuclear magnetic resonance spectroscopy was performed on a Bruker Avance 500. The ¹H NMR spectra were recorded at 500 MHz and ¹³C NMR spectra at 125 MHz in CDCl₃. The chemical shifts are reported in ppm relative to tetramethylsilane (TMS) as the internal standard. Elemental analysis was performed using a Carlo-Erba CHN 1106 elemental analyzer. Mass spectra were obtained on a Finnigan 4021 instrument.

Synthesis of dispiro[adamantane-2,1'-cyclopropane-2',2''-adamantane] (1) by the reaction of [2,2']biadamantylidene with Me₃Al and CH₂I₂. To a solution of 0.536 g of [2,2']biadamantylidene (2 mmol) and 0.64 mL of CH₂I₂ (8 mmol) in CH₂Cl₂ (8 mL), 0.8 mL of Me₃Al (8 mmol) (caution: organoaluminums are pyrophoric and can ignite on contact with air, water or any oxidizer) was added at 0 °C under an argon atmosphere. The mixture was stirred at room temperature for 18 hours. Then, the reaction mixture was diluted with 5 mL of CH₂Cl₂ and 3 mL of water was added dropwise while cooling the reactor flask in an ice bath. The precipitate was filtered on a filter paper. The aqueous layer was extracted with diethyl ether (3×5 mL). The combined organic layers were washed with brine (10 mL), dried over anhydrous CaCl₂ and concentrated to give crude product that was recrystallized from hexane to afford 1 (0.50 g, 88%) as a white crystals. Mp 124-126 °C. ¹H NMR (δ, ppm, J/Hz): 0.03 (s, 2H, C(2)H₃), 1.49 (br s,

4H, C(3)H), 1.73 (d, J = 12, 4H, C(4)H_a), 1.78 (br s, 4H, C(8)H₂), 1.81 (d, J = 12, 4H, C(5)H_a), 1.86 (d, J = 12, 4H, C(4)H_b), 1.92 (s, 2H, C(6)H₂), 1.96 (s, 2H, C(7)H₂), 2.03 (d, J = 12, 4H, C(5)H_b). ¹³C NMR (δ, ppm): 25.90 (C(2)), 27.96 (2C, C(7)), 28.30 (2C, C(6)), 32.26 (4C, C(3)), 37.15 (4C, C(4)), 37.58 (4C, C(5)), 37.92 (2C, C(8)). MS (m/z, %): 282 (100) [M]⁺, 267 (<1), 239 (6), 225 (4), 187 (2), 161 (8), 135 (23), 119 (12), 91 (28), 79 (29), 67 (14), 41 (10). Anal. calcd for C₂₁H₃₀, (%): C, 89.29; H, 10.71. Found, %: C, 89.14, H, 10.65.

The reaction of [2,2']biadamantylidene with Et₃Al and CH₂I₂. Using the procedure described and Et₃Al instead of Me₃Al gave the reaction mixture that was analyzed by GC. The GC yield of **1** was 30%.

The reaction of [2,2']biadamantylidene with CF₃CO₂ZnCH₂I. The reaction was carried out analogously to the procedure described.⁴ To freshly distilled CH₂Cl₂ (2 mL) was added Et₂Zn (0.42 mL, 4 mmol) under N₂ (it is best to use an inlet adapter for the nitrogen line since needles often become clogged). The solution was cooled in an ice bath and a solution of trifluoroacetic acid (0.32 mL, 4 mmol) in CH₂Cl₂ (1 mL) was then injected very slowly into the reaction mixture via syringe. Upon stirring for 20 min, a solution of CH₂I₂ (0.32 mL, 4 mmol) in CH₂Cl₂ (5 mL) was added. After an additional 20 min stirring, a solution of [2,2']biadamantylidene (0.27 g, 1 mmol) in CH₂Cl₂ (1 mL) was added, and the ice bath was removed. After additional 30 min stirring, the reaction mixture was quenched with aq. 0.1 N HCl (5 mL) (or sat. aqueous NH₄Cl) and dichloromethane (3 mL) and the layers were separated. The aqueous layer was extracted with dichloromethane. The combined organic layers were washed with sat. NaHCO₃, H₂O, and brine, then dried (Na₂SO₄), filtered, concentrated and the resulting reaction mixture is filtered through Al₂O₃. The GC yield of **1** was 42%.

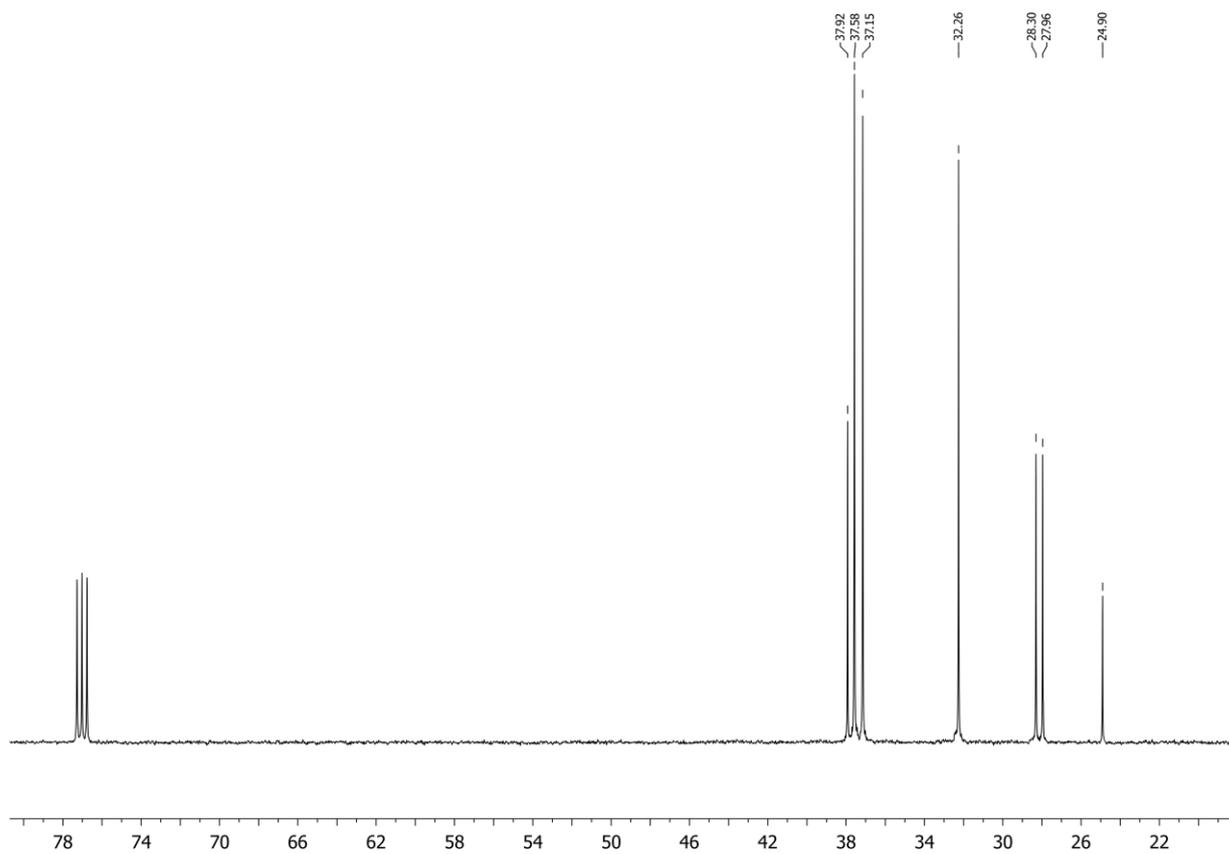
The reaction of [2,2']biadamantylidene with Et₂Zn and CH₂I₂. The reaction was carried out analogously to the procedure described. To freshly distilled CH₂Cl₂ (7 mL) was added Et₂Zn (0.42 mL, 4 mmol) under N₂ (it is best to use an inlet adapter for the nitrogen line since needles often become clogged). The solution was cooled in an ice bath and CH₂I₂ (0.32 mL, 4 mmol) was added. Upon stirring for 20 min, a solution of [2,2']biadamantylidene (0.27 g, 1 mmol) in CH₂Cl₂ (1 mL) was added, and the ice bath was removed. After additional 24 h stirring, the reaction mixture was quenched with aq. 0.1 N HCl (5 mL) (or sat. aqueous NH₄Cl) and dichloromethane (3 mL) and the layers were separated. The aqueous layer was extracted with dichloromethane. The combined organic layers were washed with sat.aq. NaHCO₃, H₂O, and brine, then dried (Na₂SO₄), filtered, concentrated and the resulting reaction mixture was filtered through Al₂O₃. Yield the cyclopropane product defined of chromatographic analysis amounted to 22%.

The reaction of [2,2']biadamantylidene with CH_2N_2 – $[\text{Pd}(\text{acac})_2]$. a) The reaction was carried out analogously to the procedure described.⁵ To [2,2']biadamantylidene (0.27 g, 1 mmol) and $\text{Pd}(\text{acac})_2$ (0.006 g, 0.02 mmol) in diethyl ether (5 mL) an ethereal solution of CH_2N_2 (10 mL, prepared from 0.735 g, 7 mmol of *N*-methyl-*N*-nitrosourea) was added dropwise at -10°C with stirring within 1 h. The mixture was then filtered through Al_2O_3 and was concentrated under reduced pressure. b) The reaction was carried out analogously to the procedure described.⁶ The [2,2']biadamantylidene (0.27 g, 1 mmol), CH_2Cl_2 (0.5 mL) and 0.4 mL of aq. KOH solution (40%) were placed into a flask equipped with a stirrer, micropowder addition funnel and a coiled condenser. Then the first portion of *N*-methyl-*N*-nitrosourea (0.02 g) and $\text{Pd}(\text{OAc})_2$ (0.002 mmol) dissolved in CH_2Cl_2 (0.05 mL) was added at 10°C . Addition of further portions of solid *N*-methyl-*N*-nitrosourea ($\sim 0.015 \text{ g} \times \text{min}^{-1}$, total amount 0.15-0.2 g) was carried out after the start of gas evolution. The mixture was then filtered through Al_2O_3 and concentrated under reduced pressure.

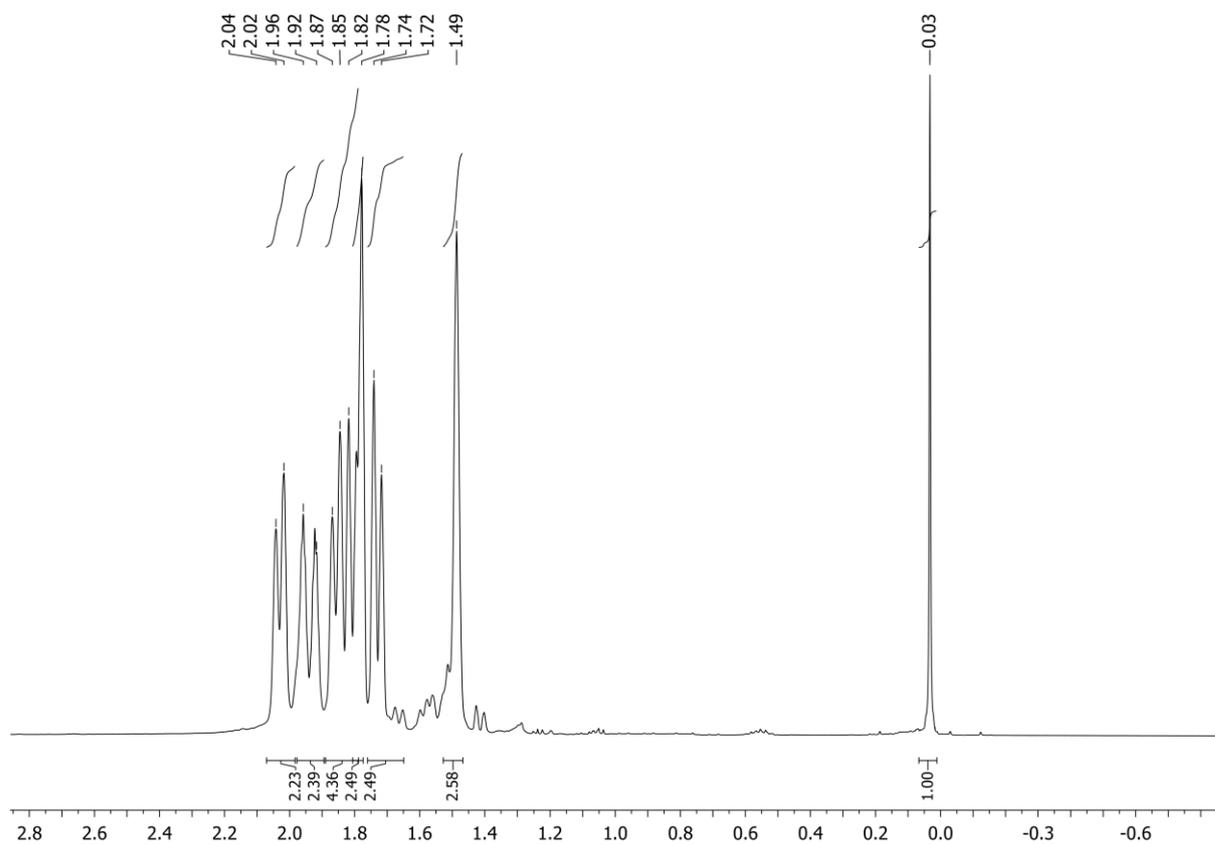
The reaction of [2,2']biadamantylidene with CH_2N_2 – CuCl - $[\text{Cu}(\text{OTf})_2]$. The reaction was carried out analogously to the procedure described.⁷ A solution of CH_2N_2 in Et_2O was prepared from *N*-methyl-*N*-nitrosourea (4.55 g, 44.2 mmol) and was added dropwise at rt to a vigorously stirred suspension of [2,2']biadamantylidene (50 mg, 0.127 mmol), CuCl (3.942 g, 39.82 mmol), and $\text{Cu}(\text{OTf})_2$ (100 mg, 0.276 mmol) in Et_2O (10 mL) over a period of 3 h. The mixture was then filtered through Al_2O_3 and concentrated under reduced pressure.

References

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^{13}C -NMR spectrum of dispiro[adamantane-2,1'-cyclopropane-2',2''-adamantane] (**1**).



$^1\text{H-NMR}$ spectrum of dispiro[adamantane-2,1'-cyclopropane-2',2''-adamantane] (**1**).