Synthesis and Physical Properties of Hexa-(−)-menthylditin and Its Derivatives[†]

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*Summary: The synthesis and physical properties of hexa-(−)-menthylditin (**1**), tri-(−)-menthyltin bromide (**2**), and allyltri-(−)-menthyltin (**3**) are reported. Full ^1H, ^{13}C, and ^{119}Sn NMR data are given.*

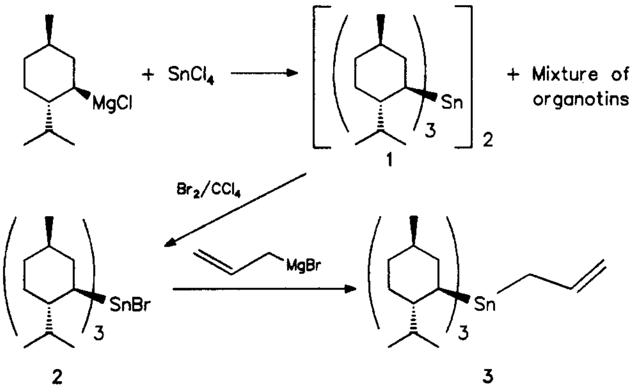
The increasing importance of organotin compounds in organic and organometallic synthesis has been noted in recent reviews and books.[1] The search for new reagents suitable for producing stereoselective transformations has been the main purpose of much research carried out over the last few decades. The application of organotin compounds with chiral ligands as reagents or intermediates in asymmetric organic synthesis is an area of fairly recent interest.[2] Thus, Otera *et al.*[2a] carried out the synthesis of secondary homoallyl alcohols by reacting allyltin compounds containing chiral organic ligands with aldehydes, obtaining enantiomeric excesses in ranges of 5−56%. Otera's best results were obtained using organotins with two chiral organic ligands. In these ligands the chiral center was placed in a β-position with respect to the tin atom. Schumann *et al.*[3] have recently shown that the synthesis of organotin compounds with chiral ligands, such as the (−)-menthyl group, can be achieved stereospecifically.

Taking into account the possibility that organotin moieties containing chiral ligands with the chiral carbon directly attached to the tin atom could exert a higher asymmetric induction than those chiral organotins in which the chiral center is more remote, we considered of interest the synthesis of (−)-menthyltin derivatives in order to study their chemical properties, especially with regard to possible applications in asymmetric synthesis.

In the present note we report the synthesis of hexa-(−)-menthylditin (**1**), a useful starting material for tri-(−)-menthyltin derivatives of potential interest as reagents for stereoselective transformations, such as allyltri-(−)-menthyltin (**3**), according to Scheme 1.

The addition of (−)-menthylmagnesium chloride in THF[5] to a solution of tin tetrachloride in benzene (Grignard/tin chloride molar ratio of 5) gave hexa-(−)-menthylditin (**1**) in 40.5% yield, plus a mixture of (−)-menthyltin compounds. This mixture could not be separated, either by column chromatography on silica gel or by fractional recrystallization (see Experimental Section). Hexa-(−)-menthylditin (**1**) is a white solid, mp 230 °C dec (EtOH), which has a specific rotation: $[\alpha]_D^{20}$ −214.8° (*c* 0.99; benzene). Using a 60% greater excess of (−)-menthylmagnesium chloride, i.e., a Grignard reagent/$SnCl_4$ ratio of 8, an increase of ca. 6% only (46.6%) in the yield of **1** was achieved.

Scheme 1



The reaction of **1** with bromine in carbon tetrachloride (bromine/tin compound molar ratio 1.1) gave tri-(−)-menthyltin bromide (**2**) in quantitative yield. The specific rotation of **2** is $[\alpha]_D^{20}$ −79.8 (*c* 1.01; benzene), substantially lower than that of **1**. The addition of a solution of **2** in ether to a cold (−10 °C) solution of allylmagnesium bromide in ether (Grignard reagent/tin bromide molar ratio 2.5) gave allyltri-(−)-menthyltin (**3**) in 84.6% yield.

^{13}C and ^{119}Sn NMR spectroscopic characteristics of compounds **1**−**3** are summarized in Table 1.

^{13}C NMR chemical shifts were assigned by taking into account the multiplicity of the signals obtained in DEPT experiments and the magnitude of the $^nJ(^{13}C,^{119}Sn)$ coupling constants, and they are in good agreement with the values reported by Schumann *et al.*[3] for a series of (−)-menthyl derivatives of tin.

Experimental Section

NMR spectra were obtained partly at Dortmund University (Dortmund, Germany; ^1H, ^{13}C, and ^{119}Sn), using a Bruker AM 300 instrument, and partly with a Bruker AC 200 instrument (^1H and ^{13}C) at IQUIOS, Rosario, Argentina. Melting points were determined on a Kofler hot stage and are uncorrected. Microanalyses were performed at Dortmund University and INQUIMAE, Universidad de Buenos Aires (Buenos Aires, Argentina). Specific rotations were determined with a Polar

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(1) (a) Neumann, W. P. *Synthesis* **1987**, 665. (b) Pereyre, M.; Quintard, J. P.; Rahm, A. *Tin in Organic Synthesis*; Butterworths: London, 1987. (c) Harrison, P. G. *Chemistry of Tin*; Blackie: Glasgow and London, 1989.

(2) Some examples are: (a) Otera, J.; Yoshinaga, Y.; Yamaji, T.; Yoshioka, T.; Kawasaki, Y. *Organometallics* **1985**, *4*, 1213. (b) Schanzer, A.; Libman, J.; Gottlieb, H. E. *J. Org. Chem.* **1983**, *48*, 4612. (c) Schumann, H.; Pachaly, B.; Schuetze, B. C. *J. Organomet. Chem.* **1984**, *265*, 145.

(3) (a) Gielen, M. *Acc. Chem. Res.* **1973**, *6*, 193. (b) Gielen, M. *Pure Appl. Chem.* **1980**, *52*, 657.

(4) (a) Schumann, H.; Wassermann, B. *J. Organomet. Chem.* **1989**, *365*, C1. (b) Schumann, H.; Wassermann, B. C.; Hahn, F. E. *Organometallics* **1992**, *11*, 2803. (c) Schumann, H.; Wassermann, B. C.; Pickardt, J. *Organometallics* **1993**, *12*, 3051.

(5) Tanaka, M.; Ogata, I. *Bull. Chem. Soc. Jpn.* **1975**, *48*, 1094.

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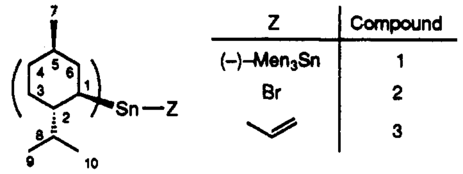
Table 1. ^{13}C and ^{119}Sn NMR Characteristics of Compounds 1−3[a]



compd. no.	$\delta(C_1)$ (^1J)	$\delta(C_2)$ (^2J)	$\delta(C_3)$ (^3J)	$\delta(C_4)$	$\delta(C_5)$ (^3J)	$\delta(C_6)$ (^2J)	$\delta(C_7)$	$\delta(C_8)$ (^3J)	$\delta(C_9)$	$\delta(C_{10})$	$\delta(^{119}Sn)$
1	39.57 (196.4)[b]	46.32 (19.0)[c]	27.60 (48.2)	35.72	36.52 (63.7)	45.50	22.41	34.35 (11.8)	22.12	17.32	18.8
2	43.40 (292.2)	46.33 (12.9)	26.97 (66.1)	35.11	35.26 (68.2)	40.82 (17.8)	22.47	34.82 (21.6)	21.99	16.70	105.0
3[d]	35.93 (310.4)	46.35 (14.7)	26.95 (54.4)	35.40	35.24 (56.6)	41.38 (17.6)	22.57	33.61 (15.0)	22.00	16.57	−73.0

[a] In $CDCl_3$; chemical shifts, δ, in ppm vs central peak of $CDCl_3$ or Me_4Sn (^{119}Sn NMR); coupling constants $^nJ(^{119}Sn,^{13}C)$ in Hz. [b] Plus ^2J(C,Sn,Sn), 34.0. [c] Plus ^3J(C,C,Sn,Sn), 14.0. [d] Other signals: 20.15 (^1J(Sn,C) 195.3); 138.78 (^2J(Sn,C) 36.4); 150.14 (^3J(Sn,C) 40.7).

L-μP, IBZ messtechnik. All the solvents and reagents used were analytical reagent grade.

Hexa-(−)-menthylditin (1). To a vigorously stirred solution of $SnCl_4$ (12.4 g, 47.5 mmol) in dry benzene (48 mL), cooled to 0 °C and placed in a two-necked round-bottomed flask with a pressure-equalizing funnel and a reflux condenser with a nitrogen seal attached, was added dropwise a solution of (−)-menthylmagnesium chloride in dry THF[4] (150 mL of a 1.58 M solution, 237 mmol). The mixture was heated under reflux for 4 h and then was left for 12 h with stirring at room temperature. HCl was then added (ca. 10 mL of a 10% solution), and the mixture was transferred to a separatory funnel. After Et_2O addition (ca. 200 mL), the organic layer was decanted, washed three times with water, and then dried with anhydrous Na_2SO_4. The solvent was removed under reduced pressure, and the crude product thus obtained was recrystallized from EtOH, yielding hexa-(−)-menthylditin (**1**) as a white crystalline solid: mp 230 °C dec; yield (10.3 g, 9.6 mmol, 40.5% yield; $[\alpha]_D^{20}$ −214° (*c* 0.99; C_6H_6). ^1H NMR ($CDCl_3$): δ 0.70−2.35 series of multiple signals from which clearly emerge three doublets, 0.80 (d, $^3J_{HH}$ = 6.7 Hz), 0.86 (d, $^3J_{HH}$ = 5.9 Hz), and 0.91 (d, $^3J_{HH}$ = 6.8 Hz). Anal. Calcd for $C_{60}H_{114}Sn_2$: C, 67.16; H, 10.71. Found: C, 66.80; H, 10.90. Removal of the solvent from the filtrate gave a mixture of (−)-menthyltin compounds as a sticky and dense material (19.4 g); the ^{119}Sn NMR spectrum showed that the mixture consisted of two tin compounds in the ratio 1.35, with the chemical shifts of 107.2 ppm (higher proportion) and 103.5 ppm. All attempts to separate the mixture either by recrystallization or by column chromatography (silica gel) failed.

Tri-(−)-menthyltin Bromide (2). To a stirred solution of **1** (7.67 g, 7.15 mmol) in CCl_4 (45 mL), cooled to 0 °C in the dark, was added dropwise a solution of Br_2 (1.26 g, 7.86 mmol). After 12 h of stirring at room temperature, the solvent was removed and **2** was obtained in quantitative yield as a pale yellow solid: $[\alpha]_D^{20}$ −75.7° (*c* 1.05; C_6H_6). One recrystallization from EtOH afforded **2** as a white, crystalline solid: mp 144.5−145.5 °C; $[\alpha]_D^{20}$ −79.8° (*c* 1.01; C_6H_6). ^1H NMR ($CDCl_3$): δ 0.70−2.20 series of multiple signals from which clearly emerge three doublets, 0.77 (d, $^3J_{HH}$ = 6.9 Hz), 0.82 (d, $^3J_{HH}$ = 6.0 Hz), and 0.91 (d, $^3J_{HH}$ = 6.6 Hz). Anal. Calcd for $C_{30}H_{57}BrSn$: C, 58.46; H, 9.32. Found: C, 58.24; H, 9.48.

Allyltri-(−)-menthyltin (3). To a stirred solution of allylmagnesium bromide in Et_2O (8.5 mL of a 1.46 M solution, 12.2 mmol), cooled to −10 °C under a nitrogen atmosphere, was added dropwise a solution of **2** (3 g, 4.87 mmol) in dry Et_2O (70 mL). The reaction mixture was heated under reflux for 2 h and then left for 12 h at room temperature. The solvent was removed, and the product was extracted three times with petroleum ether (40−60 °C; 100 mL each time). The combined extracts were filtered, and the solvent was removed. The crude product was purified by column chromatography (silica gel 60), **3** being eluted with pentane: yield 2.38 g, 84.6%; mp 73.5−75.5 °C. One recrystallization EtOH from afforded **3** as a white powder: mp 75−76 °C; $[\alpha]_D^{20}$ −64.5° (*c* 1.03; C_6H_6). ^1H NMR ($CDCl_3$): δ 0.70−2.10 series of multiple signals from which clearly emerge three doublets, 0.76 (d, $^3J_{HH}$ = 6.7 Hz), 0.84 (d, $^3J_{HH}$ = 5.4 Hz), and 0.94 (d, $^3J_{HH}$ = 6.7 Hz) (total area between 0.70 and 2.10, 59 H); δ 4.60−4.90 (m, 2H), 5.90−6.50 (m, 1H). Anal. Calcd for $C_{33}H_{62}Sn$: C, 68.63; H, 10.82. Found: C, 68.76; H, 10.75.

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Supplementary Material Available: Figures giving NMR spectra for compounds **1**−**3** (7 pages). Ordering information is given on any current masthead page.

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