η^1-Pentamethylcyclopentadienyl-substituted Silicon Compounds

A. H. Cowley,[a] **E. A. V. Ebsworth,**[b] **S. K. Mehrotra,**[a] **D. W. H. Rankin,**[b] **and M. D. Walkinshaw**[b]

[a] *Department of Chemistry, University of Texas at Austin, Austin, Texas 78712, U.S.A.*
[b] *Department of Chemistry, University of Edinburgh, Edinburgh, EH9 3JJ, U.K.*

The syntheses of the first pentamethylcyclopentadienyl compounds of silicon are described; the structure of $(\eta^1\text{-}Me_5C_5)SiCl_3$ has been determined by X-ray crystallography.

Pentamethylcyclopentadienyl compounds of the main-group elements are of interest because their structures and properties often differ significantly from those of the corresponding cyclopentadienyl derivatives. Amongst the Group 4A elements, Me_5C_5 compounds have been reported for Ge,[1,2] Sn,[1—3] and Pb,[4] but not for Si. We report (i) the syntheses of $(Me_5C_5)SiCl_3$ (1) and $(Me_5C_5)SiHCl_2$ (2), (ii) metathesis reactions of (2), and (iii) the X-ray crystal structure of (1), to our knowledge the first such data for a monohapto-Me_5C_5 compound.

Pentamethylcyclopentadienyltrichlorosilane (1) was prepared in 40% yield by the slow addition of $SiCl_4$ (63.9 mmol) to a solution of Me_5C_5Li (63.9 mmol) in 400 ml of Et_2O. Filtration of the reaction mixture, followed by evaporation of solvent left a colourless oil, b.p. 60 °C (0.05 Torr), which crystallised when left to stand at room temperature. Compound (1) was characterised by elemental analysis, mass spectroscopy [m/z 268 (M^+)], and n.m.r. spectroscopy; ^1H n.m.r. (CH_2Cl_2) δ 1.78 (s); ^{13}C n.m.r. (CH_2Cl_2) δ 12.57 p.p.m. (s, Me_5C_5). Interestingly, (1) can be handled in air for short periods of time; moreover all the compounds described herein exhibit long-term stability at ambient temperature. The latter

observation provides an interesting contrast with C_5H_5 compounds of silicon which are not stable under these conditions.[1,5] An X-ray crystal structure of (1) was undertaken to elucidate the environment of the $SiCl_3$ moiety.

Crystal data: $C_{10}H_{15}Cl_3Si$, $M = 269.71$, orthorhombic, space group $Pnam$, $a = 8.284(3)$, $b = 12.645(1)$, $c = 12.836(2)$ Å, $U = 1345$ Å^3, $Z = 4$, $D_C = 1.33$ g cm^{-3}, $\lambda(Mo\text{-}K_\alpha) = 0.71069$ Å, $\mu(Mo\text{-}K_\alpha) = 7.3$ cm^{-1}. The structure was solved by direct methods. Full-matrix least-squares refinement using 1212 observed reflections yielded a conventional R value of 0.048.†

The C_5 ring of (1), which is essentially planar,‡ is attached to Si in the monohapto-manner (Figure 1). The n.m.r. spec-

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† The atomic co-ordinates for this work are available on request from the Director of the Cambridge Crystallographic Data Centre, University Chemical Laboratory, Lensfield Road, Cambridge CB2 1EW. Any request should be accompanied by the full literature citation for this communication.

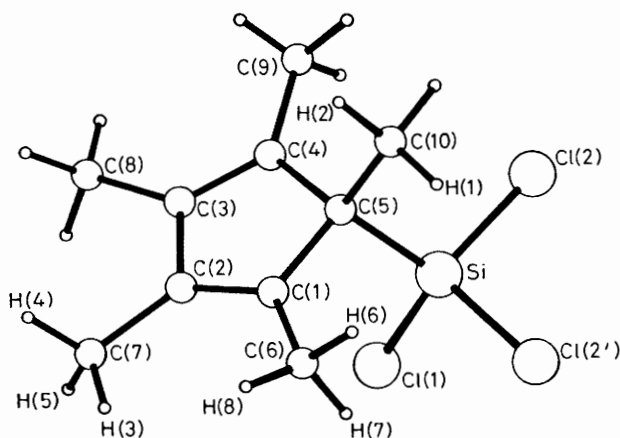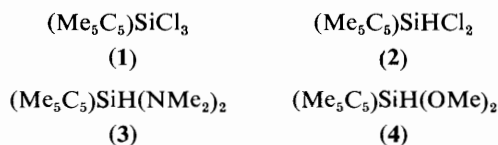‡ The average root mean square deviation from the best plane is 0.007 Å.

Figure 1. Molecular structure of (η^1-Me$_5$C$_5$)SiCl$_3$ (**1**). The molecule possesses a plane of symmetry passing through Cl(1), Si, C(5), C(10), and H(2) and bisecting the C(2)–C(3) bond. Important bond lengths are Si–C(5) 1.867(3), Si–Cl(1) 2.011(1), and Si–Cl(2) 2.036(1) Å. Important bond angles are C(5)–Si–Cl(1) 112.5(1), C(5)–Si–Cl(2) 112.2(1), Cl(1)–Si–Cl(2) 107.5(1), and Cl(2)–Si–Cl-(2′) 104.4(1)°.

tral equivalence of the ring Me groups must therefore arise from circumannular migration of the SiCl$_3$ group. The Si–C bond length of 1.867(3) Å is quite normal;[6] however, the steric demands of the Me$_5$C$_5$ group are evident from the fact that the Cl–Si–Cl bond angles of the SiCl$_3$ moiety are 2—5° less than the tetrahedral angle.

The dichlorosilane (Me$_5$C$_5$)SiHCl$_2$ (**2**) [b.p. 50 °C (0.05 Torr)] was prepared in 60% yield by the action of Me$_5$C$_5$Li on SiHCl$_3$ as described above for (**1**). The structure assignment for (**2**) follows from spectroscopic data: mass spectrum [m/z 234 (M^+)]; ^{1}H n.m.r. (CH$_2$Cl$_2$) δ 1.82 (15H, s, Me$_5$C$_5$) and 4.05 (1H, s, SiH); ^{13}C n.m.r. (CH$_2$Cl$_2$) δ 11.76 (s, Me$_5$C$_5$) and 121.92 p.p.m. (s, Me$_5$C$_5$).

$$(Me_5C_5)SiCl_3 \qquad\qquad (Me_5C_5)SiHCl_2$$
$$(\mathbf{1}) \qquad\qquad\qquad (\mathbf{2})$$
$$(Me_5C_5)SiH(NMe_2)_2 \qquad (Me_5C_5)SiH(OMe)_2$$
$$(\mathbf{3}) \qquad\qquad\qquad (\mathbf{4})$$

As in the case of the bulky (Me$_3$Si)$_3$C substituent,[7] replacement of one Si–Cl by an Si–H bond facilitates nucleophilic substitution at silicon. Thus, whereas (**1**) reacts incompletely with excess of Me$_2$NH or MeOH–Et$_3$N in n-hexane solution, (**2**) reacts readily under these conditions to produce virtually quantitative yields of (Me$_5$C$_5$)SiH(NMe$_2$)$_2$ (**3**) and (Me$_5$C$_5$)SiH-(OMe)$_2$ (**4**). Compounds (**3**) and (**4**) were characterised by elemental analysis and spectroscopy: (**3**) [b.p. 53—56 °C (0.05 Torr), m/z 252 (M^+)]; (**4**) [b.p. 46—48 °C (0.05 Torr), m/z 226 (M^+)]. ^{1}H n.m.r. (**3**) (CH$_2$Cl$_2$) δ 1.78 (15H, s, Me$_5$C$_5$), 2.36 (12H, s, Me$_2$N), and 4.24 (1H, s, SiH); (**4**) (CH$_2$Cl$_2$) δ 1.92 (15H, s, Me$_5$C$_5$) and 2.62 (6H, s, OMe); ^{13}C n.m.r. (**3**) (CH$_2$Cl$_2$) δ 11.90 (s, Me$_5$C$_5$) and 38.69 p.p.m. (s, Me$_2$N); (**4**) δ 11.98 (s, Me$_5$C$_5$) and 51.85 p.p.m. (s, MeO).

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