

cis-Bis(acetonitrile)tetrachlorotin(IV) acetonitrile solvate, *cis*-tetrachlorobis(propionitrile)tin(IV) propionitrile solvate, *cis*-tetrachlorobis(isobutyronitrile)tin(IV), *cis*-tetrachlorobis(cyclohexanecarbonitrile)tin(IV) and *cis*-tetrachlorobis(*o*-toluonitrile)tin(IV), all determined at ca 150 K

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The structures of the title compounds, $[\text{SnCl}_4(\text{C}_2\text{H}_3\text{N})_2] \cdot \text{C}_2\text{H}_3\text{N}$, $[\text{SnCl}_4(\text{C}_3\text{H}_5\text{N})_2] \cdot \text{C}_3\text{H}_5\text{N}$, $[\text{SnCl}_4(\text{C}_4\text{H}_7\text{N})_2]$, $[\text{SnCl}_4(\text{C}_7\text{H}_{11}\text{N})_2]$ and $[\text{SnCl}_4(\text{C}_8\text{H}_7\text{N})_2]$, were determined with the intention of examining the effect of various substituent types in nitrile ligands, RCN , behaving in a common σ -donor situation [in this case, as *cis*-bis complexes with SnCl_4 , *viz.* $[\text{SnCl}_4(\text{RCN})_2]$], on (i) the strength of complex formation with the metal atom and (ii) other bonding behaviour of the metal (for example, *trans* effects). The five structures exhibit no non-trivial systematic perturbation that can be said to be contingent on the substituent type.

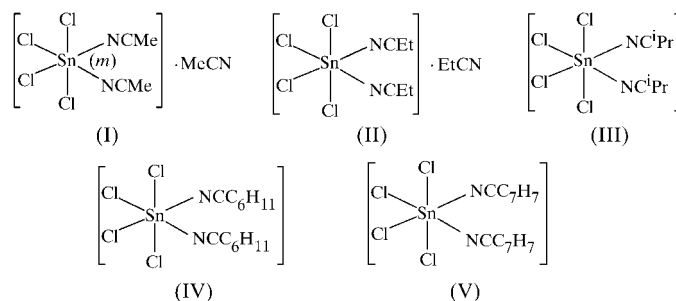
Comment

Organic nitrile ligands in their coordination complexes with metal atoms are commonly regarded as both σ -donors and π -donors, which, having a triple bond ($\text{RC}\equiv\text{N}$), should be particularly appropriate for the transmission of electronic effects of the R substituent through the bonding scheme linking it to the metal. Presumably, any such effect will be superimposed on the common observation of the lengthening of the $\text{C}\equiv\text{N}$ bond on coordination. The substituent is well removed from the metal and should not interact sterically with the rest of the coordination environment, unless the substituent is unusually bulky. However, the rod-like nature of the ligand may render it susceptible to substantial consequences of packing forces, which are usually manifested in deviations from linearity of the MNC linkage, NCR being less susceptible. Such effects can be explored spectroscopically, but in the

present context, we wanted to examine the question from a structural perspective. The chosen vehicle for the study was the array of bis(monodentate nitrile) complexes of stannic chloride. Only the structure of the acetonitrile complex has been recorded previously (Webster & Blayden, 1969), showing the metal-atom stereochemistry to be quasi-octahedral six-coordinate, with the nitrile ligands in *cis* positions in the coordination sphere, *cis*- $[\text{SnCl}_4(\text{MeCN})_2]$, in a situation where the σ -donor character of the ligand might be expected to predominate. [Two determinations of the one-dimensional polymer stannic chloride–glutaronitrile (1/1) are recorded (Barnhart *et al.*, 1968; Liu, 1985), also with two nitrile donors from different ligands in *cis* positions in the coordination sphere.]

Attempts were made to crystallize a number of such complexes from solutions of stannic chloride in various nitriles under Schlenk conditions, by volume reduction and/or by cooling as necessary. Well formed colourless crystals were obtained for a diverse array of substituents, R [R is methyl, ethyl, isopropyl, cyclohexyl (cy) and *o*-tolyl (*o*-tol)], and were subjected to structural study.

Stannic chloride crystallizes from acetonitrile solution as $\text{SnCl}_4 \cdot 3\text{MeCN}$. In the belief that one of the acetonitrile groups was uncoordinated in the original determination, $\text{SnCl}_4 \cdot 2\text{MeCN}$ was obtained by pumping on the solid *in vacuo* and recrystallizing the material from carbon tetrachloride, the results of the determination establishing the stereochemistry (Webster & Blayden, 1969). In the present study, it was considered worth establishing the nature of the 3MeCN adduct, which was found to be the monosolvate of the *cis*-bis complex, *cis*- $[\text{SnCl}_4(\text{MeCN})_2] \cdot \text{MeCN}$, (I). The asymmetric unit of the structure contains one-half of the formula unit. The complex molecule is disposed about the crystallographic mirror plane in space group $Pnma$, and the Sn atom and the pair of mutually *trans* Cl atoms lie in the plane. The substrate molecule is well defined (Fig. 1*a*), but not so much as to permit refinement of the H-atom parameters at the periphery of the ligand, where the displacement parameters are higher. The MeCN molecule of crystallization is more problematic; it is seemingly disordered over a continuous undulating sequence of residues passing through the cell in the b direction and is modelled with the terminal C atom in the mirror plane, with full site occupancy, and the CN group disposed to either side, with an occupancy of 0.5 (Fig. 1*b*).



The propionitrile adduct, similarly a *cis*-bis(ligand) complex, is also a monosolvate, *viz.* *cis*- $[\text{SnCl}_4(\text{EtCN})_2] \cdot \text{EtCN}$,

(II), and there is one formula unit devoid of crystallographic symmetry in the asymmetric unit of the structure. A projection of the molecule is shown in Fig. 2(a); the molecules stack in columns along *b*, with the voids between them occupied by the uncoordinated solvent molecules (Fig. 2b). The cyclohexylcarbonitrile (cyCN) adduct, (IV), is also of the same type, *viz.* it is unsolvated and there is one molecule of *cis*-[SnCl₄(cyCN)₂], devoid of crystallographic symmetry, in the asymmetric unit (Fig. 3a); the cyclohexyl rings adopt 'chair' configurations, with the associated CN substituents appended axially.

The *o*-toluonitrile (*o*-tolCN) adduct, *cis*-[SnCl₄(*o*-tolCN)₂], (V), is likewise unsolvated, with one molecule (Fig. 3b) in the asymmetric unit. The similarly unsolvated isobutyronitrile adduct, [SnCl₄(*i*PrCN)₂], (III), has two molecules devoid of crystallographic symmetry in the asymmetric unit. Geometric

parameters of the individual molecules are summarized in Tables 1–5 and the molecules are depicted in Figs. 1–3.

The earlier structure of [SnCl₄(MeCN)₂] (Webster & Blayden, 1969) was derived from a room-temperature film determination and, although not inharmonious with the present determination, is not sufficiently precise to justify inclusion in any survey of trends or correlations. In general, the molecules of all five title complexes are of the form *cis*-[(nitrile ligand)₂SnCl₄], with or without an uncoordinated solvent molecule. Defining the *trans* Cl–Sn–Cl group as 'axial' and the remaining N₂SnCl₂ quasi-plane as 'equatorial' (eq), we find in all cases that the Cl_{eq}–Sn–Cl_{eq} angle is enlarged beyond 90° by a significant margin, while the N–Sn–N angle is concomitantly diminished. This behaviour is consistent with the Sn–N bonds being weaker than the Sn–Cl bonds. The Cl_{ax}–Sn–Cl_{ax} angle deviates significantly from linearity, being folded towards the N atoms and away from the 'equatorial' Cl atoms, which again is consistent with the bonds from the latter being stronger (Kepert, 1982).

Focusing on possible correlations between stereochemical parameters and substituents is little more enlightening. The Sn–Cl_{ax} and Sn–Cl_{eq} bonds in all five compounds fall in a

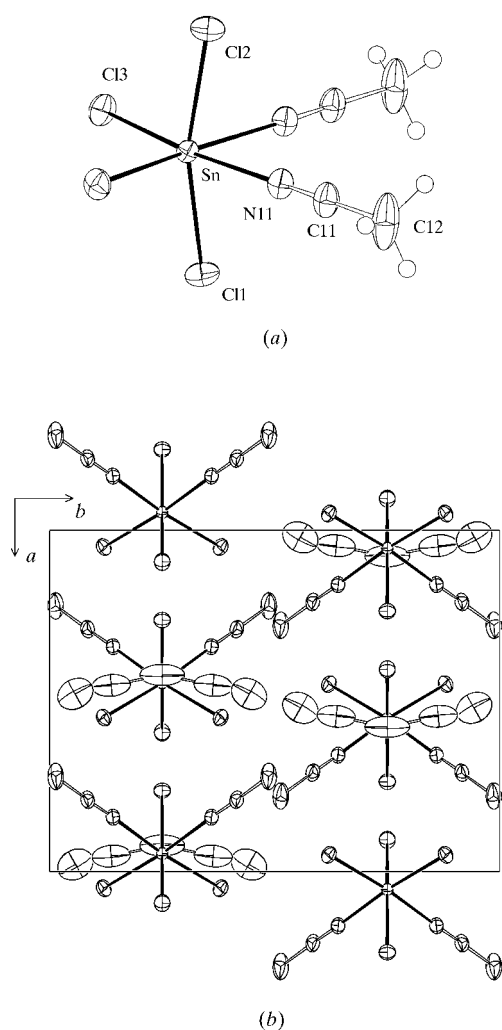


Figure 1

(a) A molecular projection of the *cis*-[SnCl₄(MeCN)₂] part of (I). Displacement ellipsoids are shown at the 50% probability level for non-H atoms. (b) A projection of the unit cell of (I) along *c*. The crystallographic mirror plane passing through the molecule lies at *y* = ¼ *etc.* The strings of solvate residues passing through the structure in the *b* direction are shown.

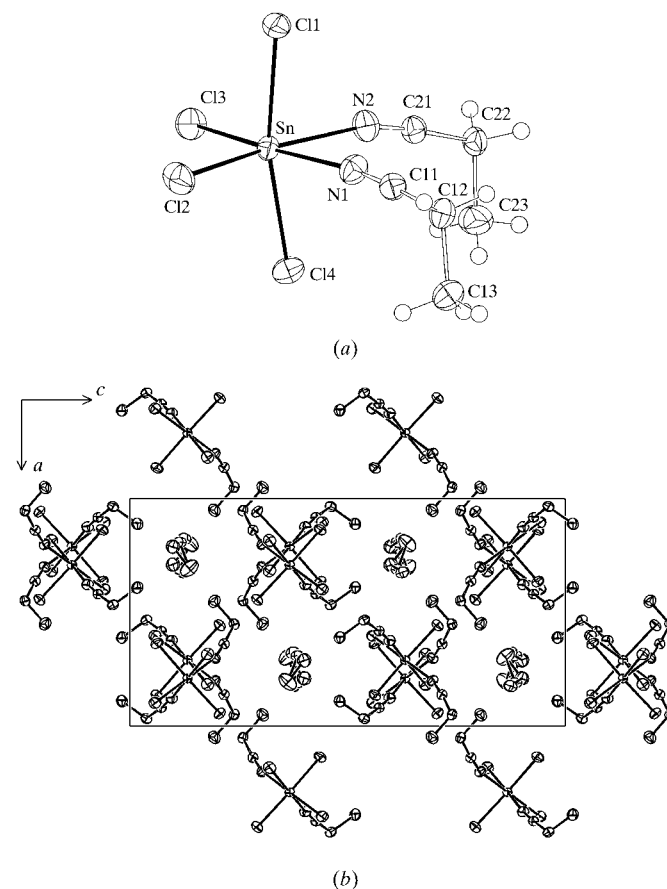


Figure 2

(a) A molecular projection of the *cis*-[SnCl₄(EtCN)₂] part of (II). Displacement ellipsoids are shown at the 50% probability level for non-H atoms. (b) A projection of the unit cell of (II) along *b*, showing the tunnels through the structure containing the solvent molecules.

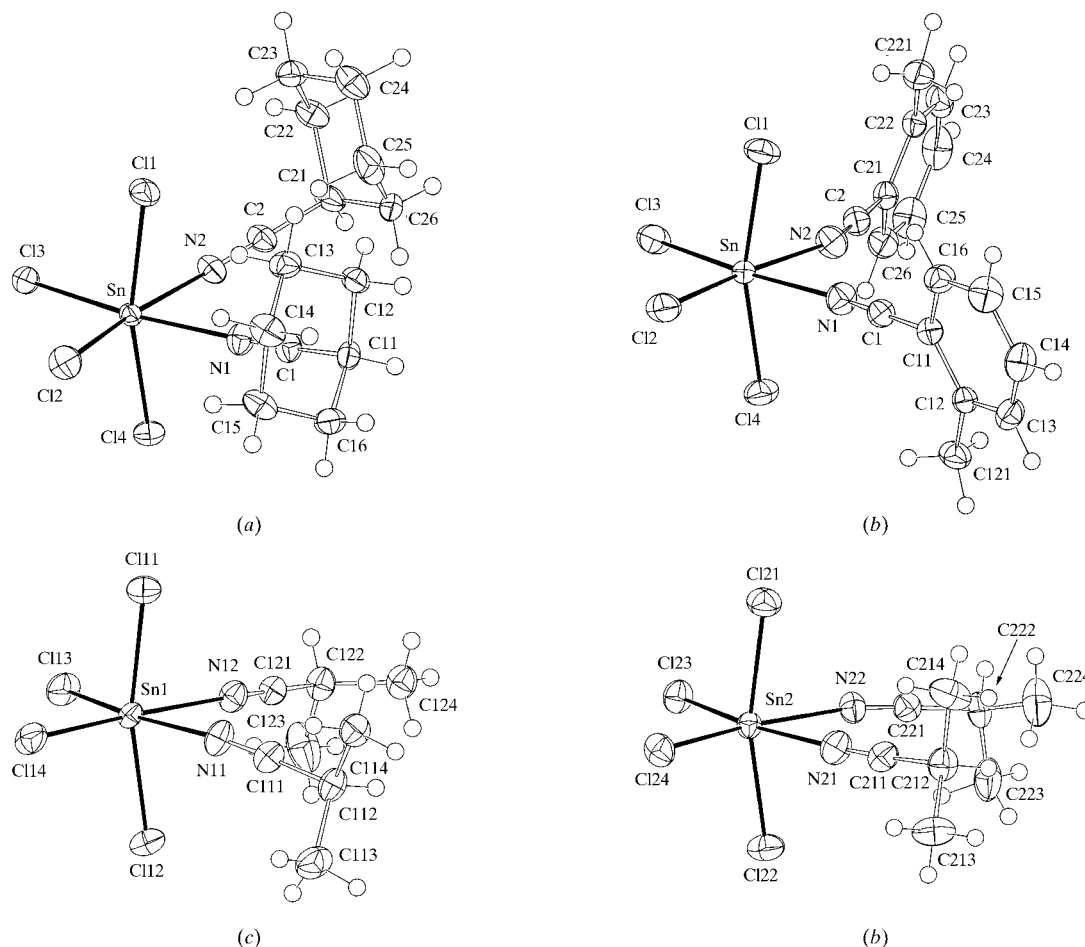


Figure 3

Molecular projections of (a) *cis*-[SnCl₄(cyCN)₂], (IV), (b) *cis*-[SnCl₄(*o*-tolCN)₂], (V), (c) molecule 1 of *cis*-[SnCl₄(^{*i*}PrCN)₂], (III), and (d) molecule 2 of (III). Displacement ellipsoids are shown at the 50% probability level for non-H atoms.

narrow range [2.3520 (11)–2.3761 (12) Å], with relatively wide divergences in any given bond type for a specific compound [e.g. the Sn–Cl_{ax} bonds for *R* = cy are 2.3488 (5) and 2.3732 (5) Å]. The Sn–N distances range between 2.255 (4) and 2.276 (4) Å, again with disparities within the familial groups (both of these values are for the isobutyronitrile adduct), rendering attempts to extract significant trends from what is again a narrow range thoroughly insecure. The same is true of the N–C distances [1.126 (6)–1.1428 (18) Å]. These values are similar to those reported recently for a free acetonitrile ligand [1.141 (2) Å; Brackemeyer *et al.*, 1997], which implies that the numerous suggestions of a dependence of this bond on coordination, admittedly contingent on the nature of the metal, perhaps should be subject to closer scrutiny and that libration corrections may be necessary. The range of Sn–N–C angles found in single compounds [e.g. 158.21 (15)–167.85 (15)° for *R* = *o*-tol and 163.2 (4)–174.8 (3)° for *R* = ^{*i*}Pr] suggest that ‘packing forces’ may be responsible for the many substantial perturbations and variations evident in the other angles. The above results suggest that substituent effects in nitrile ligand complexes of the type presented here

may be difficult to detect and apprehend by structural methods alone and that spectroscopic methods (e.g. Kawano *et al.*, 1976) may be more apposite when based on precise geometries, such as those offered here. Finally, note that, although the *cis* configuration of the above compounds is consistent with weak Sn–N bonds (as supported by bond-angle evidence), the Sn–N and Sn–Cl distances are little different from those in [SnCl₄(bpy)] [bpy is bipyridyl; Sn–N = 2.226 (4) and 2.247 (4) Å, and Sn–Cl = 2.359 (2)–2.409 (1) Å; Zakharov *et al.*, 1991] and [SnCl₄(phen)]·C₆H₆ [phen is 1,10-phenanthroline; Sn–N = 2.234 (8)–2.251 (8) Å and Sn–Cl = 2.361 (3)–2.410 (4) Å; Hall & Tiekink, 1996].

Experimental

All compounds, being highly sensitive to exposure to air, were obtained by the addition of distilled stannic chloride to the appropriate nitrile (~10 ml, freshly distilled from calcium hydride) in a Schlenk tube. The reaction mixtures were allowed to stand until crystals were deposited, and these crystals were transferred directly from the Schlenk tube to the low-temperature stream.

Compound (I)

Crystal data

[SnCl₄(C₂H₅N)₂]-C₂H₅N
M_r = 383.68
 Orthorhombic, *Pnma*
a = 10.480 (2) Å
b = 13.783 (2) Å
c = 9.758 (2) Å
V = 1409.5 (4) Å³
Z = 4
D_x = 1.808 Mg m⁻³

Mo *K*α radiation
 Cell parameters from 8148 reflections
 θ = 2.6–26°
 μ = 2.54 mm⁻¹
T = 150 (2) K
 Prism, colourless
 0.24 × 0.20 × 0.15 mm

Data collection

Bruker SMART CCD diffractometer
 ω scans
 Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)
T_{min} = 0.64, *T_{max}* = 0.80
 13 399 measured reflections

1841 independent reflections
 1726 reflections with *I* > 2σ(*I*)
R_{int} = 0.025
 θ_{max} = 28.4°
h = -13 → 13
k = -18 → 18
l = -13 → 13

Refinement

Refinement on *F*
R = 0.019
wR = 0.022
S = 1.16
 1726 reflections
 80 parameters
 H-atom parameters not refined
w = 1/(σ²*F* + 0.002*F*²)

(Δ/σ)_{max} = 0.024
 $\Delta\rho_{\text{max}}$ = 0.57 e Å⁻³
 $\Delta\rho_{\text{min}}$ = -0.54 e Å⁻³
 Extinction correction: Zachariasen (1967)
 Extinction coefficient: 1.07 (5) × 10³

Table 1
 Selected geometric parameters (Å, °) for (I).

Sn—Cl1	2.3518 (10)	N11—C11	1.132 (3)
Sn—Cl2	2.3641 (10)	C11—C12	1.453 (4)
Sn—Cl3	2.3635 (7)	N21—C21	1.137 (18)
Sn—N11	2.259 (2)	C21—C22	1.605 (15)
Cl1—Sn—Cl2	164.87 (3)	Cl3—Sn—N11	172.56 (5)
Cl1—Sn—Cl3	95.77 (2)	Sn—N11—C11	178.5 (2)
Cl1—Sn—N11	85.03 (6)	N11—C11—C12	178.9 (3)
Cl2—Sn—Cl3	94.12 (2)	N21—C21—C22	178.5 (10)
Cl2—Sn—N11	83.71 (6)		

Compound (II)

Crystal data

[SnCl₄(C₃H₅N)₂]-C₃H₅N
M_r = 425.76
 Orthorhombic, *Pbca*
a = 11.274 (2) Å
b = 13.822 (2) Å
c = 21.606 (3) Å
V = 3366.8 (9) Å³
Z = 8
D_x = 1.680 Mg m⁻³

Mo *K*α radiation
 Cell parameters from 6924 reflections
 θ = 2.6–29.3°
 μ = 2.14 mm⁻¹
T = 150 (2) K
 Block, colourless
 0.40 × 0.20 × 0.15 mm

Data collection

Bruker SMART CCD diffractometer
 ω scans
 Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)
T_{min} = 0.43, *T_{max}* = 0.75
 50 732 measured reflections

6697 independent reflections
 4991 reflections with *I* > 2σ(*I*)
R_{int} = 0.042
 θ_{max} = 34.1°
h = -17 → 17
k = -21 → 21
l = -34 → 34

Refinement

Refinement on *F*
R = 0.027
wR = 0.034
S = 1.11
 4991 reflections
 154 parameters

H-atom parameters not refined
w = 1/(σ²*F* + 0.0004*F*²)
 (Δ/σ)_{max} = 0.008
 $\Delta\rho_{\text{max}}$ = 0.93 e Å⁻³
 $\Delta\rho_{\text{min}}$ = -0.76 e Å⁻³

Table 2
 Selected geometric parameters (Å, °) for (II).

Sn—Cl1	2.3609 (6)	Sn—N1	2.2388 (18)
Sn—Cl2	2.3653 (6)	Sn—N2	2.2508 (18)
Sn—Cl3	2.3634 (6)	N1—C11	1.136 (3)
Sn—Cl4	2.3699 (6)	N2—C21	1.128 (3)
Cl1—Sn—Cl2	94.68 (2)	Cl3—Sn—N1	172.09 (4)
Cl1—Sn—Cl3	94.44 (2)	Cl3—Sn—N2	90.35 (5)
Cl1—Sn—Cl4	167.095 (18)	Cl4—Sn—N1	84.48 (5)
Cl1—Sn—N1	85.98 (5)	Cl4—Sn—N2	83.94 (5)
Cl1—Sn—N2	86.12 (5)	N1—Sn—N2	81.79 (7)
Cl2—Sn—Cl3	98.88 (2)	Sn—N1—C11	172.75 (17)
Cl2—Sn—Cl4	93.82 (2)	N1—C11—C12	176.1 (2)
Cl2—Sn—N1	88.96 (5)	Sn—N2—C21	165.66 (17)
Cl2—Sn—N2	170.64 (5)	N2—C21—C22	174.8 (2)
Cl3—Sn—Cl4	93.82 (2)		

Compound (III)

Crystal data

[SnCl₄(C₄H₇N)₂]
M_r = 398.74
 Monoclinic, *P*₂₁/*n*
a = 15.912 (3) Å
b = 12.316 (3) Å
c = 16.638 (4) Å
 β = 107.478 (3)°
V = 3110.1 (12) Å³
Z = 8

D_x = 1.703 Mg m⁻³
 Mo *K*α radiation
 Cell parameters from 8192 reflections
 θ = 3.4–26.6°
 μ = 2.31 mm⁻¹
T = 150 (2) K
 Prism, colourless
 0.20 × 0.10 × 0.08 mm

Table 3
 Selected geometric parameters (Å, °) for (III).

Sn1—Cl11	2.3659 (11)	C121—C122	1.464 (7)
Sn1—Cl12	2.3684 (11)	Sn2—Cl21	2.3761 (12)
Sn1—Cl13	2.3586 (11)	Sn2—Cl22	2.3584 (12)
Sn1—Cl14	2.3593 (13)	Sn2—Cl23	2.3580 (13)
Sn1—N11	2.255 (4)	Sn2—Cl24	2.3520 (11)
Sn1—N12	2.260 (4)	Sn2—N21	2.256 (4)
N11—C111	1.135 (6)	Sn2—N22	2.276 (4)
C111—C112	1.473 (6)	N21—C211	1.131 (7)
N12—C121	1.137 (6)	N22—C221	1.126 (6)
Cl11—Sn1—Cl12	166.41 (4)	Cl21—Sn2—Cl22	165.93 (5)
Cl11—Sn1—Cl13	95.49 (4)	Cl21—Sn2—Cl23	94.33 (4)
Cl11—Sn1—Cl14	94.33 (4)	Cl21—Sn2—Cl24	94.18 (4)
Cl11—Sn1—N11	84.97 (9)	Cl21—Sn2—N21	84.31 (10)
Cl11—Sn1—N12	85.97 (9)	Cl21—Sn2—N22	85.28 (9)
Cl12—Sn1—Cl13	94.14 (4)	Cl22—Sn2—Cl23	94.21 (4)
Cl12—Sn1—Cl14	93.52 (4)	Cl22—Sn2—Cl24	95.05 (4)
Cl12—Sn1—N11	83.36 (9)	Cl22—Sn2—N21	85.14 (10)
Cl12—Sn1—N12	85.20 (9)	Cl22—Sn2—N22	83.49 (10)
Cl13—Sn1—Cl14	99.45 (5)	Cl23—Sn2—Cl24	101.51 (4)
Cl13—Sn1—N11	165.89 (11)	Cl23—Sn2—N21	168.83 (10)
Cl13—Sn1—N12	85.72 (9)	Cl23—Sn2—N22	90.40 (11)
Cl14—Sn1—N11	94.57 (11)	Cl24—Sn2—N21	89.65 (10)
Cl14—Sn1—N12	174.76 (9)	Cl24—Sn2—N22	168.08 (11)
N11—Sn1—N12	80.23 (14)	N21—Sn2—N22	78.45 (14)
Sn1—N11—C111	168.0 (4)	Sn2—N21—C211	174.8 (3)
N11—C111—C112	177.7 (4)	N21—C211—C212	176.3 (4)
Sn1—N12—C121	163.2 (4)	Sn2—N22—C221	170.4 (4)
N12—C121—C122	177.3 (5)	N22—C221—C222	176.9 (5)

Data collection

Bruker SMART CCD diffractometer
 ω scans
 Absorption correction: multi-scan (SADABS; Sheldrick, 1996)
 $T_{\min} = 0.67$, $T_{\max} = 0.83$
 30 610 measured reflections

Refinement

Refinement on F
 $R = 0.033$
 $wR = 0.04$
 $S = 1.23$
 5976 reflections
 271 parameters

Compound (IV)

Crystal data

[SnCl₄(C₇H₁₁N)₂]
 $M_r = 478.87$
 Monoclinic, $P2_1/c$
 $a = 10.0990$ (15) Å
 $b = 15.772$ (2) Å
 $c = 12.5100$ (19) Å
 $\beta = 104.719$ (3)°
 $V = 1927.2$ (5) Å³
 $Z = 4$

Data collection

Bruker SMART CCD diffractometer
 ω scans
 Absorption correction: multi-scan (SADABS; Sheldrick, 1996)
 $T_{\min} = 0.49$, $T_{\max} = 0.75$
 28 748 measured reflections

Refinement

Refinement on F
 $R = 0.021$
 $wR = 0.03$
 $S = 1.10$
 6663 reflections
 278 parameters

Table 4

Selected geometric parameters (Å, °) for (IV).

Sn—Cl1	2.3732 (5)	Sn—Cl4	2.3488 (5)
Sn—Cl2	2.3620 (4)	N1—C1	1.1408 (19)
Sn—Cl3	2.3682 (5)	N2—C2	1.1428 (18)
Cl1—Sn—Cl2	93.420 (18)	Cl2—Sn—Cl4	95.270 (17)
Cl1—Sn—Cl3	94.129 (16)	Cl3—Sn—Cl4	95.443 (15)
Cl1—Sn—Cl4	165.871 (12)	N1—C1—C11	176.53 (16)
Cl2—Sn—Cl3	99.240 (14)	N2—C2—C21	174.19 (16)

Compound (V)

Crystal data

[SnCl₄(C₈H₇N)₂]
 $M_r = 494.82$
 Monoclinic, $P2_1/n$
 $a = 15.355$ (1) Å
 $b = 7.3810$ (6) Å
 $c = 18.083$ (2) Å
 $\beta = 104.977$ (2)°
 $V = 1979.8$ (3) Å³
 $Z = 4$

7872 independent reflections
 5976 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.041$
 $\theta_{\text{max}} = 29.0^\circ$
 $h = -21 \rightarrow 20$
 $k = -16 \rightarrow 16$
 $l = -22 \rightarrow 22$

H-atom parameters not refined
 $w = 1/(\sigma^2 F + 0.0004 F^2)$
 $(\Delta/\sigma)_{\text{max}} = 0.003$
 $\Delta\rho_{\text{max}} = 1.74 \text{ e \AA}^{-3}$
 $\Delta\rho_{\text{min}} = -0.97 \text{ e \AA}^{-3}$

$D_x = 1.650 \text{ Mg m}^{-3}$
 Mo $K\alpha$ radiation
 Cell parameters from 8030 reflections
 $\theta = 2.6\text{--}29.2^\circ$
 $\mu = 1.88 \text{ mm}^{-1}$
 $T = 150$ (2) K
 Plate, colourless
 $0.45 \times 0.45 \times 0.15 \text{ mm}$

7502 independent reflections
 6663 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.031$
 $\theta_{\text{max}} = 33.5^\circ$
 $h = -15 \rightarrow 14$
 $k = -24 \rightarrow 24$
 $l = -19 \rightarrow 19$

All H-atom parameters refined
 $w = 1/(\sigma^2 F + 0.00032 F^2)$
 $(\Delta/\sigma)_{\text{max}} = 0.024$
 $\Delta\rho_{\text{max}} = 0.57 \text{ e \AA}^{-3}$
 $\Delta\rho_{\text{min}} = -0.56 \text{ e \AA}^{-3}$

Data collection

Bruker SMART CCD diffractometer
 ω scans
 Absorption correction: multi-scan (SADABS; Sheldrick, 1996)
 $T_{\min} = 0.72$, $T_{\max} = 0.77$
 29 755 measured reflections

Refinement

Refinement on F
 $R = 0.027$
 $wR = 0.034$
 $S = 0.99$
 6555 reflections
 208 parameters

7717 independent reflections
 6555 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.031$
 $\theta_{\text{max}} = 34.0^\circ$
 $h = -23 \rightarrow 22$
 $k = -11 \rightarrow 11$
 $l = -28 \rightarrow 28$

H-atom parameters not refined
 $w = 1/(\sigma^2 F + 0.0004 F^2)$
 $(\Delta/\sigma)_{\text{max}} = 0.007$
 $\Delta\rho_{\text{max}} = 0.97 \text{ e \AA}^{-3}$
 $\Delta\rho_{\text{min}} = -1.10 \text{ e \AA}^{-3}$

Table 5

Selected geometric parameters (Å, °) for (V).

Sn—Cl1	2.3560 (7)	Sn—N1	2.2687 (16)
Sn—Cl2	2.3678 (6)	Sn—N2	2.2658 (16)
Sn—Cl3	2.3606 (7)	N1—C1	1.139 (2)
Sn—Cl4	2.3488 (7)	N2—C2	1.142 (2)
Cl1—Sn—Cl2	95.67 (2)	Cl3—Sn—N1	172.36 (4)
Cl1—Sn—Cl3	94.78 (2)	Cl3—Sn—N2	88.92 (4)
Cl1—Sn—Cl4	163.987 (19)	Cl4—Sn—N1	84.02 (5)
Cl1—Sn—N1	84.00 (5)	Cl4—Sn—N2	84.28 (5)
Cl1—Sn—N2	83.84 (5)	N1—Sn—N2	83.45 (6)
Cl2—Sn—Cl3	98.13 (2)	Sn—N1—C1	167.85 (15)
Cl2—Sn—Cl4	94.82 (2)	N1—C1—C11	178.6 (2)
Cl2—Sn—N1	89.50 (4)	Sn—N2—C2	158.21 (15)
Cl2—Sn—N2	172.95 (4)	N2—C2—C21	178.5 (2)
Cl3—Sn—Cl4	95.69 (2)		

H atoms were located from difference Fourier maps. For (I), (II), (III) and (V), H atoms were then placed in idealized positions [C—H = 0.95 Å, $U_{\text{iso}}(\text{H}) = 1.25U_{\text{eq}}(\text{C})$ for CH and CH₂, and $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{C})$ for CH₃]. For (IV), H atoms were refined isotropically, resulting in refined C—H distances in the range 0.79 (2)–1.06 (2) Å.

For all compounds, data collection: SMART (Siemens, 1995); cell refinement: SAINT (Siemens, 1995); data reduction: Xtal3.5 (Hall *et al.*, 1995); structure solution: SIMPEL in Xtal3.5; structure refinement: CRYLSQ in Xtal3.5; molecular graphics: Xtal3.5; software used to prepare material for publication: BONDLA and CIFIO in Xtal3.5.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: FG1697). Services for accessing these data are described at the back of the journal.

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