HETEROMETALLIC TIN COMPOUNDS: CLASSIFICATION AND ANALYSIS OF CRYSTALLOGRAPHIC AND STRUCTURAL DATA: PART 1. DIMERIC DERIVATIVES

Clive E. Holloway*[1] and Milan Melník[2]

[1] Department of Chemistry, York University, 4700 Keele St., Toronto, M3J 1P3. Ontario, Canada
[2] Department Chemistry, Slovak Technical University, Radlinskeho 9, SK 812 37, Bratislava, Slovak Republic

This review covers the crystallographic data for dimeric tin compounds with one other metal atom centre, following the pattern of the previous reviews on tin coordination and organometallic compounds. Over two hundred and forty such derivatives have been characterised, twenty three with a non-transition heterometal atom, one with an actinide metal and the rest with a transition metal atom. The predominant geometries of the tin and the heteroatom are discussed along with the relationships between atom size, bond distances and bond angles. The occurrences of direct metal-metal bonds, and examples of isomerism are illustrated

CONTENTS

0. ABBREVIATIONS

ab	1-tert-butyl-2-methyl-1,2-azaborolinyl
acac	acetylacetonate
bao	benzamidoxime
bdpp	2,4-bis(diphenylphosphino)pentane
bpy	2,2'-bipyridyl
Bu	butyl
Bu^t_2bpy	5,5'-di-tert-butyl-2,2'-bipyridyl
C_2H_4	ethylene
C_4H_7	2-methylallyl
C_7H_7	cycloheptatrienyl
C_8H_{14}	cyclooctene
$C_{14}H_{10}$	anthracene
4-cha	4-chloroaniline
chx	cyclohexyl
chxe	cyclohex-2-enyl
cod	1,5-cyclooctadiene
cp	cyclopentadienyl
cp*	pentamethylcyclopentadienyl
cpch	$C_5H_4(CH_3)CNN(CO)Ph$
cph	$C_5H_4(CH_3)CNNHC_6H_3(NO_2)_2$
dbf	dibenzofuran
dbm	dibenzoylmethanate
dma	3-(dimethylamino)propyl
dmamp	(o-dimethylaminomethyl)phenyl

dman	8-(dimethylamino)-1-naphthyl
dmphen	2,9-dimethyl-1,10-phenanthroline
dme	1,2-dimethyoxyethane
dppbp	2,11-bis{(diphenylphosphino)methyl}benzo-[c]-phenanthrene
dppe	bis(diphenylphosphine)ethane
dppm	bis(diphenylphosphine)methane
dppmp	(o-diphenylphosphinomethyl)phenyl
dppp	bis(diphenylphosphine)propane
dtc	1-(1,3-dithia-2-yl)cyclohexandienyl
dth	2,5-dithiahexane
dto	dithioxalate
gch	glyoxal-bis(cyclcohexylimine)
$HB(mpz)_3$	hydrotris(1-3,5-dimethylpyrazolyl)borate
$HBpz_3$	hydrotris(pyrazolyl)borate
in	indenyl
m	monoclinic
Me	methyl
mdbp	2-methyl-2(3,5-di-tert-butylphenyl)propyl
msb	N,N'-bis(3-methoxysalicylidene)butane-1,4-diamine
msp	N,N'-bis(3-methoxysalicylidene)propane-1,3-diamine
nbd	norbornadiene
np_3	tris(2-diphenylphosphinoethyl)amine
oep	2,3,7,8,12,13,17,18-octaethylporphinate
Ph	phenyl
pmdeta	$(Me_2NCH_2CH_2)_2NMe$
py	pyridine
salen	N,N'-1,2-ethylenebis(salicylideneamide)
salpr	N,N'-1,2-propylenebis(salicylideneamide)
tb	$2,4,6\text{-}\{(Me_3Si)_2C\}_3C_6H_2$
tbp	2,4,6-tri-tert-butylphenyl
tfb	tetrafluorobenzobarrelene
thf	tetrahydrofuran
tip	$2,4,6\text{-}(Me_2C)_3C_6H_2$
tol	toluene
tpp	tetraphenylporphyrinate
tr	triclinic
triphos	$CH_3C(CH_2PPh_2)_3$

1. INTRODUCTION

The chemistry of tin covers a wide range of compounds, many of which are important in the fields of catalysis and biochemistry. Up to the middle of 1997 there have been nearly three thousand structural determinations of tin compounds, including over six hundred coordination derivatives [1] and almost two thousand organometallic derivatives [2,3,4]. While only about eighteen dimeric heterometallic compounds of lead were structurally determined in the same period [5], this review surveys about twenty times as many heterometallic compounds of tin. The heterometal includes both non-transition, transition and one of the actinide metals. The structures are organised in this sequence, and within each hetero-metal by increasing Sn-M distance.

2. DIMERIC COMPOUNDS

2.1 A-Group (Non-Transition) Metals

Crystallographic and structural data for some twenty three tin heterometallic compounds with sub-group A, or non-transition metals, are summarised in Table 1. These are listed in their Periodic Group order, with the typical metals of each group first, and then the Sn-M distance. The first eight derivatives contain tin with lithium [6-13], with the tin in the +2 oxidation state and lithium in its usual +1 oxidation state. The shortest Sn-Li bond

distance is found in a yellow derivative [6] at 277.6(4) pm. Here, three Ph(Bu^t)CN ligands bridge the lithium and tin atoms via their N atoms, with Sn-N-Li bridge angles of 81.5(1)°. A slightly longer Sn-Li distance of 278.4(4) pm is found in a cyclometalated dimer [7] held together by bridging O atoms of three 2,6-diphenylphenoxide ligands, with mean Sn-O-Li bridge angles of 84.5(2)°.

Two crystallographically independent molecules within the asymmetric units of $Ph_3SnLi(pmdeta)$ [8] differ essentially by degree of distortion. While the Sn(II) atom is coordinated by three phenyl groups, the Li(I) atom utilises the tridentate pmdeta moiety. Four coordination is accomplished by each metal via a direct Sn-Li bond of 286.1(7) and 288.2(7) pm in the respective distortion isomers. Another colourless derivative [9] also contains two crystallographically independent molecules. A direct Sn-Li bond of 289(4) and 297(5) pm, respectively, hold together the N_3Sn and LiO_3 moieties.

A lithium atom in the next derivative [10] ties two amido groups together to generate an N-donor arrangement which forms part of the N_3Sn pyramid, one corner of which is the Sn(II) atom. The structure of a red derivative [11] involves a $\{(Me_3Si)_3\}_2Sn$ unit coordinated to a $LiCl(thf)_3$ moiety via a chlorine bridge. The tricoordinated Sn(II) atom is also at one corner of a pyramid. A tricoordinated tin atom is also found in a metallocyclic arrangement [12] of a four membered (Sn-P-Li-P) ring with average Sn-P-Li angles of 89.5(7)°.

The Sn centre in a sandwich style complex [13] is attached to two distorted η^3-cp ligands and the planar N atom of a $(Me_3Si)_2N$ group, as seen in Figure 1. The tin atom has a distorted pyramidal geometry, and the cp(Y) ligand holds the Sn and Li centres together in a bent π-cp fashion. The parameters involved are: Sn(1)-centroid-cp(Y)-Li(1) = 163°, centroid-cp(Y)-Li(1) = 226 pm, with the Li atom η^2 bonded to the cp ligand. The structure of a yellow derivative [14] contains the $(\pi\text{-cp})_3Sn$ unit in the form of a "paddle wheel" in which one cp ligand is also involved in a bridge to the Na atom. The Sn centre is nearly trigonal-planar, the deviation from linearity (Sn-μ-η^5cp-Na = 172.3(1)°) being almost entirely a consequence of crystal packing.

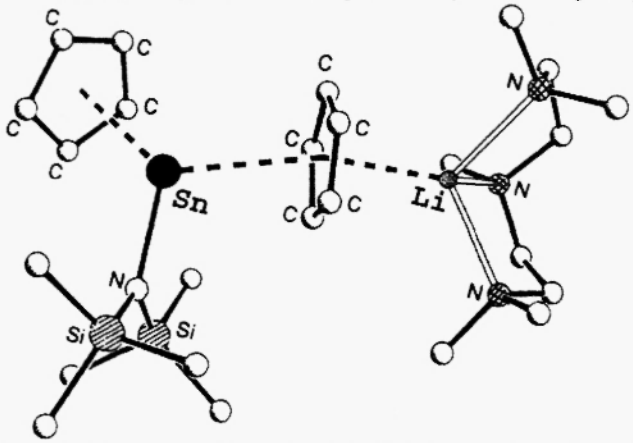

Figure 1. Structure of $cp\{(Me_3Si)_2N\}Sn(\mu\text{-}cp)Li(pmdeta)$ [13]

A potassium complex $Sn(\mu\text{-}OSiPh_3)_3K(dme)_2$ [15] exists in two different crystalline forms, monoclinic and triclinic. Both share the presence of a K-Sn unit bridged by three μ-$OSiPPh_3$ anions. The forms differ by the presence of two bidentate $MeOC_2H_4OMe$ (dme) ligands in the monoclinic form, but only one bidentate in the triclinic form, the other being monodentate. In fact, the triclinic form contains two independent molecules, both of formula $Sn(\mu\text{-}OSiPh_3)_3K(\eta^2\text{-dme})(\eta^1\text{-dme})$. All three molecules are very similar in the $Sn(OSi(Ph_3)_3K$ substructure. Superimposed drawings [15] reveal that the oxygen of the η^1-dme adopts a location between those of the two oxygen atoms of one η^2-dme in the monoclinic form. The Sn-K distances differ only slightly between the monoclinic (351.5 pm) and triclinic forms (346.0 and 348.0 pm) and rule out any direct metal-metal bond.

The structure of a yellow monoclinic derivative [16] shows the potassium atom in a distorted tetrahedral environment, with three toluene molecules coordinated to K in a 1,6-fashion with K-centroid(tol) distance of 330 pm compared to an average K-Sn distance of 354.8(3) pm (Sn-K-centroid(tol) angle of 110.5°). The Sn(II) environment, relative to the α-carbons of the neopentyl groups, is pyramidal with mean C-Sn-C angles of 91.7° suggesting that the Sn-C bonds have relatively little s-character (not given).

A colourless Sn/Al derivative [17] has a central SnO_2Al four membered ring with mean Sn-O and Al-O bond distances of 215.3(5) and 180.7(7) pm, respectively. In $Sn(\mu\text{-}OBu^t)_3Tl$ [18], which has C_3 symmetry, the

Sn(II) and Tl(I) atoms are held together by three Bu^tO ligands, resulting in a trigonal-bipyramid with the metal atoms in the apical positions and the oxygen atoms in the trigonal plane. The tin and thallium atoms come to within 330.6(3) pm of each other.

There are four isostructural derivatives [19,20] in which C_3Sn and GeC_3 moieties are held together by a direct Sn-Ge bond of average distance 259.7 pm. The mean Sn-C bond distances at 213.7 pm (methyl and 212.0 pm (phenyl) are shorter than the Ge-C values of 196.6 pm and 195.7 pm, respectively, as expected. Two crystallographically independent molecules are found within the same crystal of $Ph_3SnGeMe_3$ [19], being examples of distortion isomerism. A nearly planar four membered SnO_2Ge ring is found in another Sn/Ge compound [21] which has a cyclopentadienyl ligand on the Sn(II) and a butoxy group on the Ge(II) atom. The pyramidally configured tin and germanium centres are bridged by two tertiary butoxy groups which have a nearly planar environment but are eclipsed. The symmetrical bridging Sn-O bond distances (221 pm) are longer than the Ge-O equivalents (195 pm), as expected. Another colourless derivative has Ph_3Sn and $GePh_3$ moieties held together by a bridging oxygen atom [22] In a white derivative [23] chx_3Sn and $GePh_3$ are bridged by a hetero-bidentate arylpropionate group via oxygen to tin and carbon to germanium. Both metals are tetrahedrally coordinated with SnC_3O and GeC_4 chromophores.

A tin-lead direct bond is found in a derivative with Ph_3Sn and $PbPh_3$ moieties [24]. There are two crystallographically independent molecules with Sn-Pb bond lengths of 280.9(2) pm and 284.8(2) pm, and each metal has tetrahedral coordination.

2.2 B-Group (Transition) Metals

The crystallographic and structural data for nearly two hundred and thirty tin heterometallic compounds with transition metals are summarised in Table 2.

First in the Group IB metals, a tin-copper derivative [25] contains Cl_2Sn and CuN_3 moieties bridged by a chlorine atom with a Sn-Cl-Cu angle of 92.4(1)°. In a red derivative [26] Me_3Sn and Cu(triphos) units are linked by a hetero-bidentate η^2-CS_2 molecule giving distorted tetrahedral geometry about each metal centre (SnC_4 and CuP_3S). There are two Sn/Ag derivatives [27,28], the former of which has Cl_2Sn and Ag(dppbp) units bridged by a chlorine atom with a Sn-Cl-Ag angle of 96.4(1)°. Both Sn(II) and Ag(I) atoms have a distorted trigonal-bipyramidal geometry with chromophores of $SnCl_3$ and AgP_2Cl, respectively. Another Sn/Ag derivative [28] uses a CN ligand as a bidentate bridge (Sn-NC-Ag) giving a trigonal-bipyramidal arrangement about Sn(II) (SnC_3NCl) and an almost linear arrangement about the Ag(I) atom (AgC_2, C-Ag-C = 177.0(3)°). There is one Sn/Au derivative [29] in which Cl_3Sn and AuP_2 moieties are joined by a direct Sn-Au bond of length 288.1(1) pm. The Sn(II) atom has a distorted tetrahedral environment ($SnCl_3Au$) and the Au(I) atom has a distorted trigonal geometry (AuP_2Sn).

In Groups IIB, there are two Sn/Zn derivatives [30,31] which are quite different from each other. In one [30] the $(dma)_2Sn$ moities are connected by a direct Sn-Zn bond of 263.4(6) pm. Both metal atoms have a distorted trigonal-bipyramidal geometry, (SnN_2C_2Zn) with N atoms at the apical positions (N-Sn-N = 161.8(8)°), and ZnO_4Sn with O atoms at the apical positions (O-Zn-O = 163.1(7) pm). The other [31] has both differing oxidation states (Sn(IV) and Zn(II)) and stereochemistry (pentagonal-bipyramidal and square-pyramidal, respectively). The N,N'-bis(3-methoxysalicylidene)propane-1,3-diamine ligand is hexadentate (O_4N_2). The inner O_2N_2 coordination site of this ligand to zinc plus a nitrate group completes the square-pyramid. Two methoxy oxygens from the inner coordination site serve as bridges between the Zn and Sn atoms. The remaining two phenolic oxygen atoms plus a monodentate nitrate group completes the equatorial plane about tin. A benzyl group occupies each apical position (C-Sn-C = 168.75(9) pm).

Next, Group IVB has four Sn/Ti derivatives [32-35] listed in Table 2. A green derivative [32] has Ph_3Sn and $Ticp_2$ moieties held together by a direct Sn(II)-Ti(IV) bond of 284.3(1) pm length. There are two crystallographically independent hetero-dimers with very similar geometry. The coordination about the metal atoms is pseudo tetrahedral. In an orange-red derivative [33], a direct bond of 292.1 pm length is found between Sn(II) and Ti(0) involving chx_3Sn and $Ti(CO)_6$ units. Tellurium bridges Ph_3Sn and $Ti(cp)_2$ moieties [34] with Sn-Te and Ti-Te bond distances of 268.24(10) pm and 286.8(18) pm, respectively. The Sn-Te-Ti angle is larger than tetrahedral at 110.98(6)°. In the final derivative Me_3Sn and $TiCl_3$ units are connected by one carbon atom of a η^5-cyclopentadienyl group, with Sn-C and Ti-C bridging distances of 216.9(8) and 229.9(7) pm, respectively. There are two examples which contain both a tin and a zirconium atom [36,37]. A deep red derivative [36] has a direct Sn-Zr bond of distance 306.1(2) pm between Me_3Sn and $Zn(CO)_4(dppe)$ units. While the Sn(II) atom is

tetrahedrally coordinated (SnC_3Zr), the Zr(0) atom is seven-coordinate (ZrC_4P_2Sn). The second example is orange [37] and has a fluorine atom linking $ClMe_3Sn$ and $Zr(acac)_2cp^*$ moieties with a Sn-F-Zr angle of 146.0(1)°.

In group VB five derivatives have tin and vanadium metal centres [38-41]. In an orange derivative [38] $(Me_3Si)_3Sn$ and $V(cp)(NBu^t)$ moieties are held together by a direct Sn-V bond at 276.7(2) pm. Another orange derivative [39] also has a direct Sn-V bond, this time between Me_3Sn and $V(CO)_6$ moieties at a distance about 17.2 pm longer than the previous case [38]. In the remaining three examples [40,41] and oxygen atom bridges C_3ClSn and VO_2N_2 [40] or C_2Cl_2Sn and VO_2N_2 [41] with average Sn(IV)-O and V(IV)-O bond distances of 233.5 and 162.5 pm, respectively. The Sn-O-V bridge bond angles are 175.4(5)° [40], 172.1(3)° [41] and 163.8(3)° [41]. There are four red Sn/Nb derivatives [42-44] all with a direct Sn-Nb bond of average value 281 pm. In each case the tin atom has a distorted tetrahedral geometry, $SnCl_3Nb$ [42] and SnC_3Nb [42-44]. Lastly, one white derivative contains tin and tantalum [45]. here the Cl_2CSn and $Tacp_2(H)_2$ units are joined by a direct Sn-Ta bond of 275.291) pm.

There are over sixty derivatives with tin and a Group VIB metal. Nineteen contain chromium with tin as central atoms [46-61]. In eighteen of these [46-60] the two metals have a direct bond with lengths ranging from 256.0(3) pm [46] to 275.1910 pm [59], with an average value of 265.8 pm. The range reflects a smooth decrease in d_π-p_π interactions due to an increasing electron density at the tin atom from the former to the latter. Tin atoms are found with coordination numbers three, four and five, from which the distorted tetrahedral four-coordination is the most common. For the chromium atom the chromophore CrC_5Sn is the most common, with carbon monoxide being the most common C-donor ligand. In the monoclinic derivative $[Ph_3Sn(\mu\text{-}CNEt_2)Cr(CO)_5].0.5CH_2Cl_2$ the bridging Sn-C-Cr angle of the $CNEt_2$ group is 115.8(6)°.

There are twenty five Sn/Mo derivatives [48,59,62-79], of which twenty two have a direct Sn-Mo bond. The bond lengths range from 265.291) pm [62] to 289.89(5) pm [77] with an average value of 275 pm. The tin atoms are mostly tetrahedral with differing degrees of distortion, the exceptions being trigonal-planar [48] and trigonal-bipyramidal [64,72]. Molybdenum atoms between from six [48,77] and seven-coordination [62,64,66,69,72,74,75], and from semi-sandwich [59,68,70,71,76] to sandwich [62,65,67]. In $Me_3SnMOH_2(H)cp_2$ [67] two crystallographically independent molecules are found in the same crystal and differ mostly by degree of distortion. The structure of a red derivative [78] is shown in Figure 2. The molecule consists of a Cl_2BuSn unit attached to $Mo(CO)_2(Pcy_3)$ by a chlorine bridge and a S_2CPcy_3 bridging ligand. The latter acts as a η^2(S,S') chelate ligand to the tin atom and a η^3(S,C,S') pseudo-allyl ligand to the molybdenum. The Sn-Mo distance of 363.6(2) pm precludes a direct metal-metal bond. The tin atom is in an octahedral environment ($SnCl_3S_2C$) and the molybdenum has a highly unsymmetrical seven-coordinate environment. The remaining two SnMo derivatives [79] have a cyclopentadienyl group as a bridge between Ph_3Sn and $Mo(CO)_2(Cph)^-$ or $Mo(CO)_2(\eta^3\text{-}PhCHOEt)$ moieties.

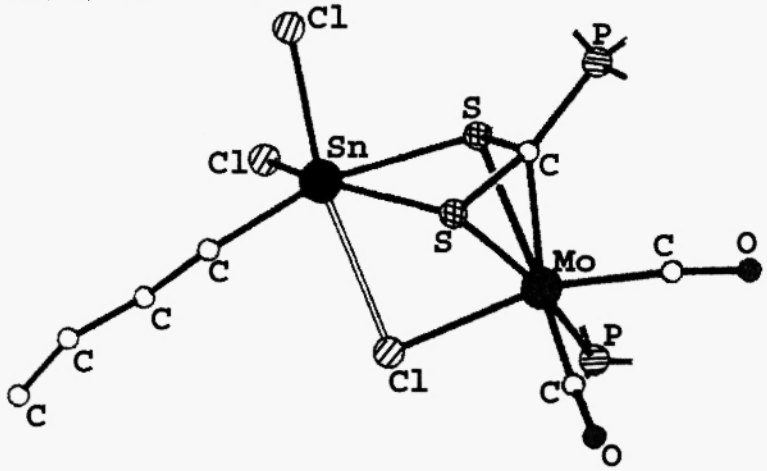

Figure 2. Structure of $[Cl_2BuSn(\mu\text{-}\eta^3\text{-}S_2CPcy_3)(\mu\text{-}ClMo(CO)_2(Pcy_3)]$[78]

There are nineteen derivatives which contain tin and tungsten atoms together [57,68,79-92]. In fifteen of these the tin and tungsten have a direct bond with bond distances ranging from 270.6(1) pm [80] to 283.7(1) pm [90], with an average value of 278 pm. The tin stereochemistry varies from trigonal-planar [83,93], pseudo-

tetrahedral [57,79-82,84-86,88-92], trigonal-bipyramidal [81,82,87] to pseudo-octahedral [68]. The tungsten environments include pseudo-octahedral [57,81-83,86,87], seven-coordinate [84,85,89], semi-sandwiched [68,88,90] and sandwich [80]. A red derivative [91] has Ph_3Sn and $W(CO)_5$ units bridged by η^2-$SCSCH_2Ph$ through a C atom giving SnC_4 and WC_5S chromophores. C_2Sn and $W(CO)_5$ units are linked by a μ-η^3-S_4 unit with two S atoms bonded to tin (pseudo-tetrahedral SnC_2S_2) and one S atom to tungsten (pseudo-octahedral WC_5S). A μ-η^3-$OP(OEt)_2PP(OEt)_2O$ ligand connects ClSn and $W(CO)_5$ [95] using two O atoms to tin (SnO_2Cl) and a P atom to tungsten (WC_5P). A cyclopentadie ⁄l ligand serves as a bridge between Ph_3Sn and $W(CO)_2(PhC)$ moieties in a final example for which little structural information is given [79].

Twenty examples are found for Group VIIB, starting with thirteen tin plus manganese derivatives [94-105]. All but the last two have a direct Sn-Mn bond ranging from 250.8(3) pm [94] to 270(1) pm [103]. All but one of the examples has a pseudo-tetrahedral tin atom (SnY_3Mn, where Y = S, Cl or C), it has a trigonal-bipyramidal environment [98]. Manganese is mostly pseudo-octahedral (MnC_5S) [95-97,90-102], with only two derivatives having a semi-sandwich arrangement [94,98]. Two of the derivatives [94,96] contain crystallographically independent heterodimers differing largely by degree of distortion. In $Ph_3SnW(CO)_5$ [101] four such heterodimers are present. Pseudo-tetrahedral geometry about tin (SnC_3O) is found in a complex with a tricarbonylmanganese unit π-bonded to a penta-substituted cyclopentadienyl ring (Ph_4C_5O). The triphenyltin and manganese units are linked by an oxygen bridge. The structure of tetracarbonylmanganese-triphenyltin dimer is shown in Figure 3. The bridging is accomplished by a μ-η^3-1,2-ethoxycarbonyl-ethen-1-yl ligand via one carbon atom to tin and the other, plus an oxygen atom, to manganese. Here the tin is pseudo-tetrahedral (SnC_4) and the manganese is pseudo-octahedral MnC_5O.

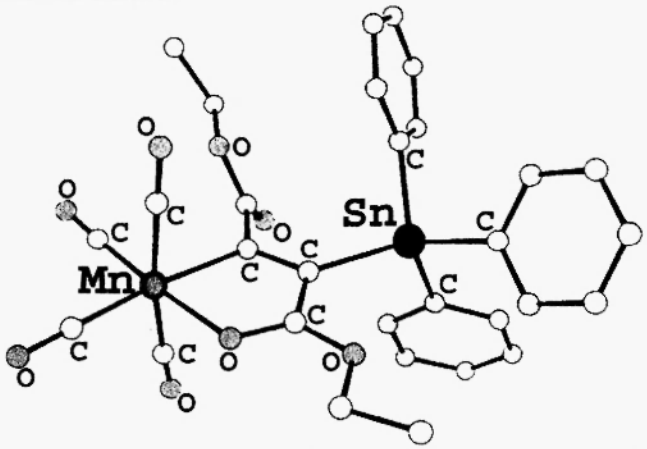

Figure 3. Structure of $Ph_3Sn\{\mu$-EtO(C(O)CHCHC(O)OEt$\}(Mn(CO)_4]$ [105]

There is only one example with tin and technetium [106]. The two metal centres are connected by a triple bridging arrangement, one of which is a single atom (hydroxo group). The other two bridges are dimethylglyoxime ligands that function as bidentate nitrogen donors to technetium and monodentate oxygen donors to tin. The tin atom can be considered as a three pronged "cap" on one side of the Tc-dimethylglyoxime complex. The additional coordination sites around Tc are taken up by the two nitrogen atoms of a third dimethylglyoxime making the metal centre seven-coordinate. The additional coordination sites around tin are occupied by three chlorine atoms giving the metal centre a fac-octahedral environment. The Sn-Tc distance of 347 pm precludes a metal-metal bond.

There are six examples with tin and rhenium [107-110], with a direct Sn-Re bond in four of them [107,108] with distances ranging from 260.9(1) to 279.3(1) pm (ave. 267 pm). Each tin atom has pseudo-tetrahedral geometry ($SnCl_3Re$, $SnCl_2CRe$ or SnC_2ClRe) and the rhenium atoms are sandwiched by cyclopentadienyl groups. The other two derivatives [109,110] are isostructural, and one of them is shown in Figure 4. Here the bridge is seen to be CO_2 molecule bridging in a μ-η^3-CO_2 fashion by both O atoms to Sn and the C atom to Re. The Sn-O bond distances are not equal, differing by 8.2 pm in the case shown [109] and much larger at 30.7 pm in the other [110]. Also, the metallocyclic ring (-SnOCO-) in the former is about 1° more open than in the latter, and the Re-C bond distance is 205.8(9) pm in the former and 210.0(9) pm in the latter.

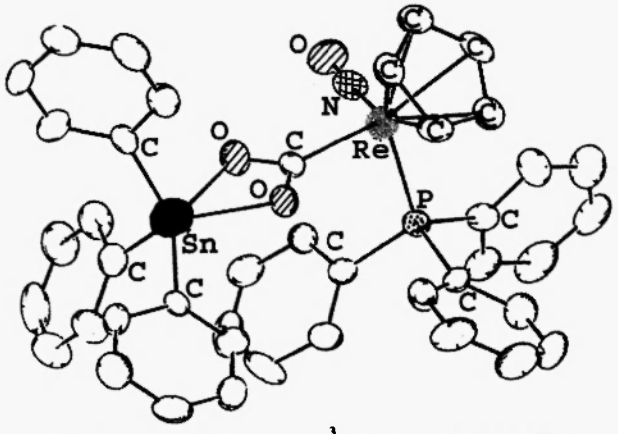

Figure 4. Structure of $Ph_3Sn(\mu\text{-}\eta^3\text{-}CO_2)Re(NO)cp(PPh_3)$ [109]

There are almost one hundred Group VIII metals found in combination with tin in binuclear complexes. Of these the most common is iron for which thirty one derivatives are listed [111-136]. Twenty two of the structures reveal that the tin and iron are directly bonded with Sn-Fe bond distances ranging from 240.8(1) pm [111] to 262.43(21) pm [128], with an average value of 253.4 pm. The stereochemistry about tin includes trigonal-planar [111,119], pseudo-tetrahedral [112-114,117,120-129], trigonal-bipyramidal [115], square-pyramidal [116] and seven-coordinate [118]. The iron centre can be found five-coordinate [111,116,126], six [125,127] and seven-coordinate [117,118,128], but the most prevalent is semi-sandwiched with two additional monodentate ligands [112-115,119-124,129]. A red derivative [130] has an iron cyclopentadienyl moiety with two P atoms of a chelating dppm ligand and an ethynyl bridge to the tin atom. The bridge (Fe-C=C-Sn) has Fe-C and Sn-C bond distances of 190.3(4) and 206.3(4) pm, respectively. Three phenyl groups complete the tetrahedral arrangement about the tin (SnC_4). Five orange and yellow derivatives are isostructural [131-133], with C_3Sn and FeC_6P or FeC_7 chromophores linked by a η^3-CO_2 molecule via both oxygen atoms to tin and the carbon atom to iron. The four-membered (-Sn-O-C-O-) metallocycle bite angle O-Sn-O and the difference between the Sn-O bond lengths. For example: 46.7 pm and 53.42(7)° [131]; 38.7 pm and 55.94(9) pm [133]; 32.7 pm and 56.5(1)° [133]; 29.2 pm and 56.90(6)° [133] and 21.9 pm and 57.4(1)° [132]. Each tin atom has a trigonal-bipyamidal environment (SnC_3O_2). The structure of a yellow complex [134] is shown in Figure 5. The cyclopentadienyl rings of the ferrocene fragment are planar with a dihedral angle between them of 1.7(2)°. The Sn-Fe separation of 367.8 pm precludes a direct metal-metal bond. In an orange complex [135] Cl_3Sn and Fecp moieties are linked by a μ-$C_5H_4S(NBu^t)_2$ group, forming a four membered SN_2Sn ring. The bridge is η^5-bonded to Fecp completing a ferrocenyl unit. The structure of another yellow derivative is shown in Figure 6. The 1,1' bis(diphenylphosphino)ferrocene ligand connects to an octahedral Sn atom through the formation of P-O bonds. The molecule has near twofold rotational symmetry through the line joining the Sn and Fe atoms. the cyclopentadienyl rings are perfectly eclipsed, but the two C_{cp}-P bonds are at an angle of 72° about the centroids of the rings.

Fourteen derivatives contain tin with cobalt [31,137-145], eleven of them have a direct metal-metal bond ranging from 243.8(1) pm [137] to 259.8(2) pm [143] (average 255.2 pm). In the first example the tin atom has a trigonal-bipyramidal environment [137], all the others have a pseudo-tetragonal tin environment [138-144]. The stereochemistry about cobalt is more varied with four-coordinate [142-144], five- [138,139,141,142], seven- [140] and eight-coordinate [137]. The derivative $Ph_3SnCO(PMe_3)_3$ [143] contains two crystallographically independent hetero-dimers differing by degree of distortion. In another derivative [145] a methoxy group on the tin(IV) atom provides a strong bridge via oxygen to the Co(III) atom. In addition, two O atoms of the salen ligand also bridge the metal centres, while bonded to Co(III) through its two N atoms. Both metal atoms are six-coordinate (SnO_3Cl_2C and CoO_3N_2Cl). The remaining two Sn/Co derivatives [31] are structurally similar to the Sn/Zn derivative in the same paper [31]. In each case the tin atom has pseudo-bipyramidal geometry (SnO_5C_2) with carbon atoms in apical positions (C-Sn-C angle of 168.95(14)° and 163.3(2)°).

TABLE 1. Crystallographic and Structural Data for Dimeric Heterometallic Tin Compounds with Non-Transition Metals[a]

COMPOUND (colour)	Crys.cl Sp.Grp Z	a [pm] b [pm] c [pm]	α [°] ß [°] γ [°]	Chromo-phore.	M-L [pm]	Sn-M [pm] Sn-L-M [°]	L-M-L [°]	Ref
[Sn{μ-NC(Bu^t)Ph}$_3$·L (thf)] (yellow)	ra $P2_1/n$ 4	1067.9(2) 3503.6(7) 1068.3(2)	106.84(3)	$Sn^{II}N_3Li$	μN^b 216.8(3,8) 219.3(2)	277.6(4) 81.5(2,7)	N,N^b 79.7(1,8)	6
				$Li^{I}N_3O$	μN 205.3(5,5) 212.5(5) O_{thf} 196.4(4)		N,N 84.4(2,1.3) O,Sn 169.8(2)	
[Sn{μ-2,6-Ph_2-C_6H_3)}$_3$Li] (colourless)	c R3 3	1074.1(2)	97.31(1)	$Sn^{II}O_3Li$	μO 215.0(2,0)	278.4(4) 84.5(2)	O O 76.0(1)	7
				$Li^{I}O_2C_2$	μO 198.8(4,0) C not given		O O 83.5(1)	
Ph_2SnLi(pmdeta)[c] (colourless)	m $P2_1/a$ 4	1232.7(2) 1757.1(4) 1267.6(3)	101.71(3)	$Sn^{II}C_2Li$ $Li^{I}N_3$ $Sn^{II}C_3Li$ $Li^{I}N_3$	C_{ph} 221.4(4,7) N not given C_{ph} 219.8(4,7.8) N not given	286.1(7) 288.2(7)	C C 96.1(2) C 4 120.7(2)	8
[{SiMe$_2$N(4-$CH_3C_5H_4$)}$_3$·$SnLi(thf)_3$][C] (colourless)	hx $P6_3$ 4	1566.4(4) - 2242.1(11)		$Sn^{II}N_3Li$ $Li^{I}O_3$	N 214.9(10,0) O 191(2,0)	289(4)	N N 92.2(4) N,Li 123.7(3) O O 112.2(11) O,Sn 106.6(13)	9
				$Sn^{II}N_3Li$ $Li^{I}O_3$	N 213.9(10,0) O 190 (2 0)	297(5)	N N 93.3(4) N Li 122.9(3) O O 107(2) O,Sn 111.5(14)	
HC{SiMe$_2$N[(S)-CH(Me)Ph]}$_3$·$SnLi(thf)$ (colourless)	or $P2_12_12_1$ 4	828.83(2) 2082.43(4) 2199.93(4)		$Sn^{II}N_3$ $Li^{I}N_2O$	N 211.8(7) μN 220.2(6,13) μN 207(2,2) O_{thf} 195(1)	84.6(5,9)	N N 82.6(2) 100.6(2,1.4) not given	10
{(Me$_3$Si)$_3$Si}$_2$Sn·(μ-Cl)Li(thf)$_3$ (red)	m $P2_1/n$ 4	1306.0 2348.4(3) 1750.0(2)	96.78(2)	$Sn^{II}Si_2Cl$ $Li^{I}O_3Cl$	Si 267.3(12,8) μCl 275.4(5) O_{thf} not given μCl 253(10)	113.0(2)	Si,Si 114.2(4) Si Cl 93.8(3,1.8) not given	11

$[(Bu^t_2P)Sn(\mu\text{-}PBu^t_2)_2\cdot Li(thf)]$	m	1159.0(2)		$Sn^{II}P_3$	P 268.4(4)	-	P,P 84.1(1)	12
(orange yellow)	$P2_1/c$	2036.6(3)	104.51(1)		μP 268.6(4,16)	89.5(7,5)	112.2(1,8.0)	
	4	1583.6(2)		Li^IP_2O	μP 248(3,1)		not given	
					O_{thf} not given			
[cp{$Me_2Si)_2NS$}Sn·	m	985.4(1)		$Sn^{II}Ncp_3$	N 218.3(2)		not given	13
(μ-cp)Li(pmdeta)]	$P2_1/c$	2293.9(2)	90.36(1)		cp 257	163		
(colourless)	4	1397.5(1)			μcp 283			
				Li^IN_3cp	N not given			
					μcp 225			
[$cp_2Sn(\mu\text{-}cp)Na$	m	871.3(2)		$Sn^{II}cp_3$	cp 253.8(1,13)		cp,cp 117.6(1,1.3)	14
(pmdeta)]	$P2_1/c$	1722.1(3)	96.60(3)		μcp 273.3(1)	172.3(1)	124.0(1)	
(yellow)	4	1634.5(3)		Na^IN_3cp	N not given			
at 153K					μcp 255.0(1)			
$[Sn(\mu\text{-}OSiPh_3)_3\cdot$	tr	2125.0(4)	93.26(1)	$Sn^{II}O_3$	μ_3O 204.9(10)	346.0(4)	O,O 88.4(4,1.0)	15
$K(dml)_2]^c$	P1	2225.8(5)	104.44(1)		208.6(9,5)			
(yellow)	4	1327.1(3)	75.79(1)	K^IO_5	O_{1me} 277.8(11,53)		O,O 60.68(49) -	
at 119K					μO 273.3(12,15)		161.45(35)	
					289.1(4)			
				$Sn^{II}O_3$	μO 205.3(10,2)	348.0(4)	O,O 88.2(4,1.6)	
					207.9(10)			
				K^IO_5	O_{dme} 266.0(25,125)		O,O 59.0(5) -	
					μO 272.2(16,34)		166.1(27)	
					298.6(12)			
$[Sn(\mu\text{-}OSiPh_3)_3$	m	1390.4(3)		$Sn^{II}O_3$	μO 205.9(2,3)	351.5(1)	O,O 89.0(1,1.6)	15
$K(dme)_2]$	$P2_1/n$	2243.1(5)	102.23(1)		209.20(22)			
(yellow)	4	1920.0(4)		K^IO_5	O_{dme} 279.6(3,52)		O,O 58.54(9) -	
at 138K					μO 281.5(2,31)		148.78(8)	
					290.39(26)			
$[Bu^t(CH_2)_3Sn\cdot$	m	1088.6(2)		$Sn^{II}C_3$	C not given	354.8(3)	C,K 124.0(4,1.5)	16
$K(C_6H_5Me)_3]$	$P2_1/c$	3509.5(16)	91.65(2)				C,C 91.7	
(yellow)	4	1013.9(2)		K^IC_X	C 321 - 372			
$[Cl Sn(\mu\text{-}OBu^t)_2\cdot$	m	1740.0(9)		$Sn^{II}O_2Cl$	μO 215.3(7,1)		O,O 69.2(2)	17a
$Al(OBu^t)]$	$P2_1/c$	905.2(8)	90.27(7)		Cl 245.2(4)	not given	O Cl 93.6(2,3)	
(colourless)	8	3118(3)		$Al^{III}O_4$	μO 180.7(7,8)		O O 85.1(3)	
					O 167.5(8,7)		115.0(4)	

$[Sn^{II}(C_{21}H_{24})$	m	1743.1(3)		Sn(centroid)$_3$	253.4		not given		17b
$Cl\,AlCl_3]\,(AlCl_4)$	$P2_1/n$	1273.8(3)	99.86(1)		264.4(-,16)				
(colourless)	4	1761.7(3)			μCl 307.3(2)				
at 223K				$AlCl_4$	Cl not given				
					μCl not given				
$Sn(\mu\text{-}OBu^t)_3Tl$	hx	994.4(5)		$Sn^{II}O_3$	μO 202.3(9,0)	330.6(3)	O O 85.6(4)		18
(colourless)	$P6_3/m$	-				90.6(3)			
	2	1107(1)		$Tl^{I}O_3$	μO 259.5(7,0)		O O 63.9(3)		
$Ph_3SnGeMe_3$[c]	or	2074.1(3)		SnC_3Ge	C_{Ph} 204.1(7,0)	256.7(6)	C C 106.8(12.4.5)		19
(colourless)	$Pna2_1$	1239.3(2)		GeC_3	C_{Me} 198.2(8,1)		C C 111(2,2)		
	4	806.4(1)					C Sn 108.6(14.2.0)		
				SnC_3Ge	C_{Ph} 209.5(7,8)	259.6(4)	C C 108.4(8,1.7)		
				GeC_3	C_{Me} 198.5(7,6)		C C 107.1(7,1.5)		
							C Sn 111.8(7,2.2)		
$Ph_3SnGeMe_3$	or	2062.6(3)		SnC_3Ge	C_{Ph} 215.4(3,9)	260.15(5)	C C 105.6(1,3)		19
(colourless)	$Pna2_1$	1238.9(2)					C Ge 112.2(1,9)		
	4	803.5(1)		GeC_3	C_{Me} 194.3(4.8)		C C 109.7(2,7)		
							C Sn 109.3(2,1.0)		
$[Ph_3SnGe(Me)_2$	m	870.4(3)		SnC_3Ge	C_{Ph} 214.2(8,3)	260.8(1)	C C 105.8(3.2.9)		20
$(SiMe_3)]$	$P2_1$	819.5(2)	99.39(3)		216.9(8)		C Ge 112.0(2,1.3)		
(colourless)	2	1929.9(6)		GeC_2Si	C_{Me} 195.5(11,12)		C C 105.2(5)		
					Si 238.6(2)		C Si 114.3(4,1.9)		
$Me_3SnGePh_3$	or	2037.3(2)		SnC_3Ge	C_{Me} 213.3(4,0)	261.06(5)	C C 109.0(2,1.1)		19
(colourless)	$Pna2_1$	1239.7(2)			214.4(4)		C Ge 109.9(1,9)		
	4	808.4(1)		GeC_3	C_{Ph} 195.7(3,3)		C C 108.0(2,7)		
							C Sn 110.9(1,1.1)		
$cpSn(\mu\text{-}OBu^t)_2$	m	1012.5(9)		$Sn^{II}O_2C$	μO 221.5(9,3)		O O 66.7		21
$Ge(OBu^t)$	Pn	1008.2(9)	104.5(7)		C_{cp} 241(2)	106.8(4,4)	O C 97.0(5)		
(colourless)	2	1067.0(9)		$Ge^{II}O_3$	μO 194.7(9,13)		O O 77.4(4)		
at 183(2)K					O 183.9(10)				
$Ph_3Sn(\mu\text{-}O)GePh_3$	tr_	1126.4(3)	92.60(2)	SnC_2O	C_{Ph} 203(1,2)		C C 111.8(5,1.3)		22
(colourless)	P1	974.4(2)	103.35(2)	(GeC_3O)	μO 186.1(8,13)	134.9(4)	C O 109.0(4,2.5)		
	2	1562.7(4)	109.48(2)						
$[chx_3Sn\{\mu\text{-}O_2CCH_2$	tr_	1121.6(3)	84.36(3)	SnC_3O	C_{chx} 208.0(2)		C C 113.5(4,2.7)		23
$CHC_6H_4CH_3\text{-}2\}Ge$	P1	1322.5(7)	85.27(2)		216.0(9,10)		C O 105.0(3,9.6)		
$Ph_3]\,CHCl_3$	2	1607.5(3)	77.45(4)		μO$_1$ 207.5(6)				
(white)				GeC_4	C_{Ph} 195.1(9,14)		C C 109.3(4,1.3)		
					μC$_-$ 195.4(8)				

$Ph_2SnPbPh_3$[c]	m	1716.9(3)		SnC_3Pb	C_{Ph} 221	280.9(2)	C C 108.7	24
(colourless)	$P2_1/n$	939.5(2)	111.02(4)				C Pb 109.4(3,2.7)	
at 233K	4	2062.4(9)		PbC_4	C_{Ph} 221(1,1)		C C 109.5(4,2.7)	
							C Sn 110.3	
				SnC_3Pb	C_{Ph} 221	284.8(2)	C Pb 111.1(3,1.5)	
				PbP_3	C_{Ph} 221(1,1)		C,C 107.8(4,2.3)	

Footnotes: a. Where more than one chemically equivalent distance or angle is present, the mean value is tabulated. The first number in parenthesis is the e.s.d., and the second is the maximum deviation from the mean.

b. The chemical identity of the coordinated atom or ligand is specified in these columns. c. Five member metallocyclic ring.

TABLE 2. Crystallographic and Structural Data for Dimeric Heterometallic Tin Compounds with Transition Metals[a]

COMPOUND (colour)	Cryst Sp.Grp Z	a [pm] b [pm] c [pm]	α [°] ß [°] γ [°]	Chromophore.	M-L [pm]	Sn-M [pm] Sn-L-M [°]	L-M-L [°]	Ref
$[Cl_2Sn(\mu\text{-}Cl)Cu(MeCN)_3]$ (colourless)	m $P2_1/n$ 4	798.4(9) 2077(2) 834(2)	101.6(1)	$Sn^{II}Cl_3$	Cl 249.4(2,17) μCl 258.1(2)	92.4(1)	Cl,Cl 90.8(1,2) 93.5(1)	25
				CuN_3C	N 195.6(6,12) μCl 245.2(2)		N N 115.5(2,6.8) N Cl 102.4(2,1.2)	
$[Me_2Sn(\mu\text{-}\eta^2\text{-}CS_2)Cu^I(triphos)]\cdot CS_2$ (red)	m $P2_1/c$ 4	1506.2(5) 1363.2(3) 2270.6(7)	91.50(2)	$Sn^{II}C_4$	C_{Me} 209.1(20,18) μC_L 217.7(17)		C C 109.5(9,5.2)	26
				Cu^IP_3S	P 229.4(5,6) μS_L 225.8(6)		P,P 94.5(2,4.0) P,S 114.6(2,1.7) 134.4(2)	
$[Cl_2Sn(\mu\text{-}Cl)Ag^I(dppbp)]$ (white)	m C2/c 8	2188 2175 2361	135.91	$Sn^{II}Cl_3$	Cl 247.9(3,19) μCl 253.4(3)	96.4(1)	Cl,Cl 93.4	27
				AgP_2Cl	P 243.5(3,16) μCl 271.3(2)		P,P 142.2(1) P,Cl 108.5(1,5.0)	
$\{N(PPh_3)_2\}[ClPh_2Sn(\mu\text{-}NC)AgCN]$ thf (white)	m $P2_1/c$ 4	918.2(5) 2441.2(10) 1708.1(8)	101.31(3)	$Sn^{II}C_3NCl$	C_{Ph} 215.8(5,20) Cl 251.8(2) μCN 243.6(5)		N Cl 175.5(1)	28
				AgC_2	μNC 206.2(6) NC 205.5(9)		C C 177.0(3)	
$Cl_3SnAu\{PMe_2Ph\}_2$	m $P2_1/m$ 2	1195.4(2) 992.5(2) 1005.9(1)	111.40(2)	$Sn^{II}Cl_3Au$	Cl 244.3(4,15)	288.1(1)	Cl,Cl 94.3(2,1.7) Cl,Au 119.4(1,6.6)	29
				AuP_2	P 231.4(4,4)		P,P 153.8(1) P,Sn 103.1(1,9)	
$[(dma)_2Sn\ Zn(dbm)_2]$ (yellow)	m C2/c 4	2479(2) 815(1) 2087(3)	115.2(1)	$Sn^{II}N_2C_2Zn$	N_{dma} 249(3,0) C_{dma} 215(4,0)	263.4(6)	N N 161.8(8) C,C 104(1) N C 77;92(1) N Zn 99.1(6) C Zn 128(1)	30
				ZnO_4	O_{dmb} 200(2,0) 207(2,0)		O O 86.1(8,2.0)[d] 163.1(7) O Sn 108.0(5,9.5)	

$[(NO_3)(bz)_2Sn$	m	1799.99(13)		$Sn^{V}O_2C_2$	O_{mps} 249.5(2,2)		C,O 67.4(1,3)[e]	31
$(\mu\text{-msp})Zn(NO_3)]$	$P2_1/n$	1057.14(8)	107.306(6)		μO_{mps} 217.2(1,4)		75.1(1,5.0)	
	4	1809.98(14)			O_2NO 241.8(2)		143.9(1,10.6)	
					C_{bz} 214.3(2,1)		C,C 168.75(9)	
							O,C 90.2(1,7.6)	
				$Zn^{II}O_3N_2$	N_{mps} 205.1(2,19)		O,O 73.56(5)	
					μO_{mps} 209.2(1,7)		92.9(1,4)	
					O_2NO 202.6(2)		N,N 96.72(8)[d]	
							O,N 88.1(1,7)[d]	
							112.7(1,1.8)	
							149.4(1,2.3)	
$Ph_3SnTicp_2Cl$[e]	tr	1729.3(5)	85.24(2)	$Sn^{II}C_3Ti$	C_{Ph} 217.1(7,7)	284.3(1)	C,C 103.2(3,1.4)	32
(green)	P1	1005.3(5)	92.06(2)				C,Ti 114.6(2,6.0)	
	4	1423.1(5)	90.45(2)	$Ti^{IV}C_{10}Cl$	C_{cp} 236(1,4)		cp,cp 132.5(2)	
					Cl 232.4(2)		Cl,Sn 86.8(1)	
				$Sn^{II}C_3Ti$	C_{Ph} 216.8(7,6)	284.3(1)	C,C 103.8(2,1.4)	
							C,Ti 114.6(2,2.9)	
				$Ti^{IV}C_{10}Cl$	cp,C 237(1,4)		cp,cp 133.1(2)	
					Cl 233.7(2)		Cl,Sn 85.7(1)	
[K(cryptand 2.2.2)]	m	1061.9(2)		$Sn^{II}C_3Ti$	C_{chx} not given	292.1	C,C not given	33
$[chx_3SnTi(CO)_6]$	$P2_1/c$	2993.6(7)	97.08(3)					
(orange red)	4	1493.4(7)		$Ti^{O}C_6$	OC 204.8(7,29)		C,C not given	
$Ph_3Sn(\mu\text{-}Te)Ticp^*_2$		not given		$Sn^{II}C_3Te$	C_{Ph} not given		C,Te 108.7(3,9)	34
					Te 268.24(10)		120.9(3)	
				$Ti^{III}cp^*_2Te$	cp^* not given			
					Te 286.81(18)			
$Me_3Sn(\mu\text{-}cp)TiCl_3$	or	1616.4(8)		SnC_4	C_{Me} 212.3(10,17)		C,C 109.4(5,6.1)	35
(dark yellow)	$Pna2_1$	719.4(5)			μC_{cp} 216.9(8)			
	4	1192.3(5)		TiC_5Cl_3	$C_{\mu cp}$ 232.1(8,16)		Cl,Cl 102.6(1,8)	
					$\mu C_{\mu cp}$ 229.9(7)			
					Cl 223.0(3,11)			
$[K(15\text{-crown-}5)_2]$	or	1735.1(7)		$Sn^{II}C_4Zr$	C_{Me} not given	306.1(2)	not given	36
$[Me_3SnZr(dppe)(CO)_4]$	$P2_12_12_1$	1679.0(5)		ZrC_4P_2	OC 218(2,5)		not given	
(deep red)	4	1990.0(8)			P 278.0(4,2)			

$[ClMe_2Sn(\mu\text{-}F)$	m	1398.4(3)		$Sn^{IV}C_3FCl$	C_{Me}	212.6(5.3)		C,C	119.0(2,4.8)	37
$Zr(acac)_2cp^*]$	$P2_1/c$	971.2(2)	101.24(3)		μF	246.2(2)	146.0(1)	C,F	84.2(2.1.7)	
(orange)	4	2130.8(4)			Cl	248.5(1)		C,Cl	95.8(2,8)	
								F,Cl	177.8(1)	
				ZrC_5OF	cp_cC	254.8(4,33)		O,O	79.8(1,7.6)	
					O	215.0(3.55)		O,F	78.2(1)	
					μF	203.0(2)			91.3(1.3.8)	
$[(Me_3Si)_3SnVcp$	or	1535.0(1)		$Sn^{II}Si_3V$	Si	258.3(4.6)	276.7(2)	S,Si	102.5(1,2.2)	38
$(NBu^t)(HNBu^t)]$	$P2_12_12_1$	1695.1(1)						S,V	115.8(1.5.2)	
(orange)	4	1245.4(1)		$V^VC_3N_2$	C_{cp}	232.5(10,56)		N,N	106.0(5)	
					N	165.4(9)		N_p	119.8(5.4.0)	
						184.1(10)		N,Sn	97.5(3,4)	
$M_3Sn V(CO)_6$	m	686.61(3)		SnC_3V	C_{Me}	not given	293.90(6)	not given		39
(orange)	$P2_1/m$	1173.1(4)	104.46(2)							
	2	897.9(1)		VC_6	OC	201.4		not given		
$[Ph_3ClSn(\mu\text{-}O)V$	m	1115.1(3)		$Sn^{IV}C_3OCl$	C_{Ph}	214.3(13.9)		not given		40
(salpr)]	$P2_1/n$	1129.7(3)	96.35(2)		μO	212.4.9)	175.4(5)			
	4	2522.4(5)			Cl	248.4(4)				
				$V^{IV}O_3N_2$	μO	161.7.9)		not given		
					O	189.5(9,10)				
					N	204.6(12.8)				
$[Ph_2Cl_2Sn(\mu\text{-}O)V$	tr	1166.2(2)	67.09(2)	$Sn^{IV}C_2C'_2O$	C_{Ph}	not given		not given		41
(salen)] H_2O	P1	1175.7(2)	82.55(2)		Cl	not given	172.1(3)			
	2	1211.3(2)	71.38(2)		μO	233.5(6)				
				$V^{IV}O_2N_2$	μO	162.3(6)		not given		
					O	190.2(6,1)				
					N	205.2(7,3)				
$[Ph_2Cl_2Sn(\mu\text{-}O)V$	m	1398.6(2)		$Sn^{IV}C_2C|_2O$	C_{Ph}	not given		not given		41
(3-MeOsalen)].H_2O	$P2_1/n$	2158.4(3)	109.80(2)		Cl	not given	163.8(3)			
	4	1209.8(2)			μO	230.7(5)				
				$V^{IV}O_2N_2$	μO	163.5(5)		not given		
					H_2C	232.1(5)				
					O	192.4(4.4)				
					N	205.0(6.4)				

$Cl_3SnNb(cpMe)_2(CO)$	m	893.69(15)		$SnCl_3Nb$	Cl 233.9(3)	276.4(1)	Cl,Cl 95.8(1,7)	42
(orange red)	$P2_1/n$	1335.89(12)	99.490(14)		239.5(3,5)		C,Nb 120.8(1,1.3)	
	4	1392.92(20)		$Nb^{III}C_{11}$	OC 203.1(9)		C Sn 88.8(2)	
					cp,C 234.2(0			
$Ph_3SnNbcp_2(CO)$	m	1010.21(21)		SnC_3Nb	C_{Ph} 218(2,3)	282.5(2)	C C 102.4(6,1.3)	42
(red)	$P2_1/n$	1746.33(32)	95.578(6)				C Nb 115.8(4,2.0)	
	4	1424.73(29)		$Nb^{III}C_{11}$	OC 205(2)		C Sn 85.2(5)	
					C_{cp} 234 - 24(			
$Ph_3SnNbcp(CO)_3$	m	1383.3(9)		SnC_3Nb	C_{Ph} 217.9(12,3)	282.0(2)	C,C 101.3(4,2.7)	43
(red)	$P2_1/n$	1520.6(18)	97.89(6)				C Nb 116.7(3,1.4)	
	4	1791.8(14)		NbC_8	OC 208.7(17,38)		C C 75.6(5,2.5)	
					C_{cp} 241.9		C Sn 70.7(4,1.6)	
$[Ph_3SnNb(H)_2$	m	1354.7(4)		SnC_3Nb	C_{Ph} 216.5(10,37)	283.0(1)	C C 101.4(4,2.7)	44
$(\eta^2\text{-}C_5H_4SiMe_3)_2]$	$P2_1/n$	2245.9(8)	99.00(2)				C Nb 116.7(3,2.6)	
(red)	4	1144.8(4)		$NbC_{10}H_2$	cp 206.9(9.5)		cp Sn 110.3(3,1.7)	
					H 167.(6,5)		cp,H 101(2,5)	
							H,H 120(3)	
							cp cp 139.5(4)	
$MeCl_3SnTa(H)_2Cp_2$	or	773.6(1)		$SnCl_2CTa$	Cl 243.5(3)	275.2(1)	Cl,Cl 94.6(1)	45
(white)	Pcmn	1055.2(1)			C_{Me} 213(2)		Cl C 98.9(3)	
	4	1694.3(3)					Cl Ta 112.2(1)	
							C Ta 133.0(4)	
				$TaC_{10}H_2$	C_{cp} 237(1,1)		cp,cp 140.1	
					H 161(1,0)		H,H 131.4(50)	
							H,Sn 65.9(40)	
(NPh_4)	tr	1047.2(6)	96.45(5)	$SnBr_3Cr$	Br 251.3(3,13)	256.0(3)	Br,Br 98.2(9,7)	46
$(Br_3SnCr(CO)_5]$	P1	1158.6(4)	92.26(5)					
	2	1442.0(1)	114.24(4)	CrC_5	OC not given			
$\{(Me_3Si)_2CH\}_2Sn$	m	934.0(4)		SnC_2Cr	C 218(-,1)	256.2	C C 98	47
$Cr(CO)_5$	$P2_1/c$	1354.8(8)	90.33(1)				C Cr 131(-,1)	
(orange)	4	2427.2(10)		CrC_5	OC not given			
(PPh_4)	tr_	1078.8(4)	103.01(2)	$Sn(Cl_3Cr$	Cl 239.6(1,6)	258.3(1)	Cl,Cl 95.2(4,2)	46
$[Cl_3SnCr(CO)_5]$	P1	1134.0(3)	109.20(2)				Cl,Cr 120.7(3,4.6)	
	2	1395.3(3)	95.58(2)	CrC_5	OC not given			

[(oxinato)$_2$SnCr(CO)$_5$]·0.5thf	m	1143.4(5)		SnO_2N_2Cr	O 204.9(4,0)	258.7(2)	O O 102.3(2)	46
	C2/c	1819.8(7)	100.69(3)		N 231.6(5)		N N 141.8(2)	
	4	1284.8(4)					O,N 78.1(2.2.8)[e]	
							O,Cr 128.9(1)	
							N Cr 109.1(1)	
				CrC_5	OC 183.5(9)		C C 90.2(4.2)	
					189.3(8)		178.8(4)	
							C,Sn 89.6(2)	
							180.0	
[(dtp)(mdbp)SnCr(CO)$_5$]	tr	1465.3(2)	108.446(7)	SnC_2Cr	C 218.8(5)	261.4(1)	C C 91.2(2)	48
	P1	1521.7(2)	105.274(7)		220.0(5)		C Cr 134.4(1,1)	
(yellow)	2	1121.0(1)	61.692(7)	CrC_5	OC not given			
[(py)$_2$PhP(CH$_2$-CH$_2$S)$_2$]SnCr(CO)$_5$]	tr	1065.4(2)	85.31(2)	SnS_2NPC_2	S 246.7(1.5)	261.8(1)	S,S 103.0(1)	49
	P1	1014.6(3)	79.66(2)		P 275.6(1)		S,N 84.6(1.4.2)[e]	
	2	1244.8(3)	65.53(2)		N_{py} 251.4(4)		S P 79.4(1.6)[e]	
(yellow)							N,P 153.9(1)	
							S,Cr 128.5(1,7.3)	
							N,Cr 99.4(1)	
							P,Cr 106.7(1)	
				CrC_5	OC 187.9(4.36)		C C 90.5(2,3.0)	
							177.1(2,1.5)	
							C,Sn 89.0(1,5.1)	
							172.5(2)	
[{Bu^{t}N(CH$_2$CH$_2$S)$_2$}Sn Cr(CO)$_5$]	m	1496.3(9)		SnS_2NCr	S 242.4(1,2)	252.2(1)	S S 104.9(1)	50
	P2$_1$/c	1002.6(5)	114.68(5)		N 240.0(4)		S N 83.6(1,1)[e]	
(yellow)	4	1355.5(5)					S,Cr 121.5(0,3.3)	
							N Cr 131.3(1)	
				CrC_5	OC 188.7(6.34)		C C 90.0(2,3.0)	
							176.7(2,3)	
							C,Sn 90.2(2,5.8)	
							174.1(2)	

[Na(12-crown-4)$_2$][(Pr^{i}S)$_2$SnCr(CO)$_5$] (yellow)	or Pbca 8	1579.0(2) 2044.5(6) 2588.6(3)		SnS_3Cr	Pr S	247.0(4.40)	262.7(1)	S,S	93.7(1,1.7) 110.7(1)	46
								S,Cr	118.0(1,2.4)	
				CrC_5	OC	184.0(9)		C C	90.0(4,2.2)	
						188(1)			174.1(4)	
								C Sn	87.9(3)	
									176.7(3)	
[(py)Bu$^t_2$Sn Cr(CO)$_5$] (pale yellow)	m $P2_1/n$ 4	846.6(2) 2814.9(5) 922.3(2)		SnC_2NCr	C_{Bu}	224.2(1)	265.4(3)	C,C	109.5(7)	51
					N_{py}	229(1)		C N	96.7(6,2.9)	
								C,Cr	120.2(5,6)	
								N Cr	107.8(3)	
				CrC_5	OC	185(2,4)		C,C	90.1(8,3.7)	
									176.1(9,8)	
								C S	85.9(5,3.7)	
									175.9(6)	
[Ph$_3$Sn(μ-H)Cr(cp (NO)PPh$_3$] (green)	tr P1 2	1158.2(2) 1196.1(2) 1417.4(4)	84.84(2) 68.45(2) 67.89(2)	SnC_3HCr	C_{Ph}	217.3(3,7)	266.90(7)	C C	101.6(1,3.4)	52
					μH	184	104	C,H	103(-9)	
									140	
at 200K								C Cr	116.5(1,5.3)	
								H Cr	34	
				CrC_5HNP	C_{cp}	222.4(3,19)		q_1,H	116	
					μH	155		q_1,N	127.9	
					ON	167.6(2)		q_1,P	118.03	
					P_{Ph}	236.4(1)		H N	113	
								H,P	69	
								N,P	94.6(8)	
[Ph$_3$Sn(μ-H)Cr (mes) (CO)$_2$]	m $P2_1/c$ 4	821.4(1) 997.1(1) 3126.9(3)	90.62(1)	SnC_3HCr	C_{Ph}	216.1(46)	270.16(2)	C C	104.5(1,5)	53
					μH	202(4)		C,H	95(1,5)	
									147(1)	
								C Cr	114.1(9,2.3)	
								H Cr	36(1)	
				CrC_8H				C C	84.8(11)	
					C_{mes}	not given		C,H	79(1), 112(1)	
					OC	182.2(4.1)		C Sn	73.3;102.6(1)	
					μH	159(4)		H Sn	48(1)	

$[Ph_3SnCr$	tr	896.1(4)	85.15(3)	SnC_3Cr	C_{Ph} not given	271.3(1)	not given		54
$(\eta^5\text{-}C_6H_6D)(CO)_3]$	P1	1085.3(5)	86.26(2)	CrC_8	C 219.0(6,3)		not given		
	2	1271.3(2)	72.40(4)		227.8(6,2)				
					OC 187				
$[Ph_3SnCr\{C(NEt_2)\}$	m	945.1(8)		SnC_3Cr	C_{Ph} 216(1,1)	271.9(2)	C,C 102.3(5,2.8)		55
$(CO)_4]$	$P2_1/c$	1701(3)	111.71(7)				C,Cr 115.9(4,2.1)		
	4	1817(2)		CrC_5	C_{ax} 174(1)		C,C 92.1(7.8.8)		
					OC 187(2,4)		170.9(7,3.7)		
							Sn_1C_L 174.6(5)		
$[P_{2,3}SnCr(CO)_3(dtc)]$	m	1960.4(2)		SnC_3Cr	C_{Ph} not given	271.9(2)	C,C not given		56
	$P2_1/c$	1042.0(7)	104.56(1)						
	4	1510.7(5)		CrC_8	OC 185.4(11,18)		not given		
$[Ph_2Sn\{Cr(NO)$	or	1304.6(2)		Sr_2C_2Cr	C_{Ph} 215.6(9,17)	273.73(13)	C,C 102.8(3.2.3)		57
$(MeCN)_2(CO)_2\}$	$Pna2_1$	1215.9(2)					C,Cr 115.5(2,3.9)		
(orange)	4	1535.3(3)		CrN_2C_2	ON 168.4(6)		N,N 93.9(3,9.1)		
					CN_{Me} 203.7(7,1)		C,C 87.0(4)		
					OC 186.7(10,7)		N,C 93.6(3.4.3)		
							166.6(3,1)		
							N,Sn 84.7(2.2.0)		
							173.1(3)		
							C,Sn 82.7(3,2.5)		
$[Ph_3SnCr(NO)$	m	1125.7(3)		SnC_3Cr	C_{Ph} 216.9(6,5)	274.9(1)	not given		58
$(MeCN)_2CO]_2$	$P2_1/c$	1302.5(3)	100.98(2)	CrN_2C_2P	ON 165.1(6)		N,N 99.5(2)		
$\{P(OMe)_3\}]$	4	1950.1(9)			CN_{Me} 206.3(6)		C,C 93.5(3)		
(orange)					OC 182.2(8,23)		N,P 90.7(2,6.2)		
					P 232.3(2)		C,P 90.5; 167.8(2)		
							N,Sn 83.1; 171.0(2)		
							C,Sn 80.9(2,4)		
							P,Sn 88.67(5)		
$[Me_3SnCr(CO)_3(ab)]$	tg	2339.8(6)		SnC_3Cr	C_{Me} 214.2	275.1(1)	C,Cr 111.1		59
	$P4_2/n$			CrC_6NB	OC 183.5		C,C 82.4(4,1.2)		
	8	680.7(2)			C_{ab} 218.2(11,51)		103.1(4)		
					N_{ab} 218.1(7)				
					B_{ab} 235.6(11)		C,Sn 70.1(3,2.6)		
$[Ph_3SnCr(\eta^6\text{-dbf})$	not			SnC_3Cr	C_{Ph} not given		134.7(3)		60
$(CO)_3]$	given			CrC_3	not given				

$[Ph_3Sn\{\mu\text{-}CNEt_2\}$	m	1478(5)		SnC_4	C_{Ph} 214.5(14,21)	-	C C 109.4(5.8.6)	61
$Cr(CO)_5]\ 0.5CH_2Cl_2$	$P2_1/c$	1208(4)	111.4(2)		μC 223.9(14)	115.8.6)		
	4	1854(6)		CrC_6	OC 188(2,3)		C C 90.0(8.6.6)	
					μC 211.0(14)		173.3(8,3.7)	
$Cl_4SnMo(H)(cp)_2$	m	831.3(3)		$SnCl_3Mo$	Cl 238.1(2,1)	265.2(1)	Cl,Cl 95.3(1,1.4)	62
	$P2_1/m$	1310.9(4)	106.52(2)				Cl,Mo 123.8(5.1.9)	
	?	638.4(2)		$MoC_{10}H$	C_{cp} 229.1(7,41)		cp,cp 141.3	
					H 174(7)		H,Sn 92(2)	
$\{(Ph_4B)_2CN\}$	or	1196.8(7)		$SnCl_3Mo$	Cl 230.6(6)	266.3(1)	Cl,Cl 98.6(2,1.9)	63
$[Cl_3SnMo(CNBu^t)_6]$	Pbcm	2301.2(6)			235.1(4,0)		Cl,Mo 118.9(2,1.1)	
(red)	4	2690.5(4)		MoC6	C 207.1(18.0)		C C 78.8 - 176.3(5)	
					213.8(15.1)		C,Sn 71.4(2.8)	
							122.1(3,10.6)	
$[Cl_3Sn(\mu\text{-}Cl)M_1$	$\bar{1}r$	983.5(3)	92.05(2)	$SnCl_4Mo$	Cl 231.5(5.1)	268.8(2)	Cl Cl 95.0(2,11.5)	64
$[MeS(CH_2)_2SN]e\}$	$P\bar{1}$	1106.8(3)	119.28(2)		238.1(5)	60.5(1)	Cl,Mo 55.2(1)	
$(CO)_3]\ CH_2Cl_2$	2	900.6(2)	96.36(2)		μCl 278.1(4)		117.8(2.2)	
				MoC_3S_2Cl	OC 200.2,4)		C C 77.7(8.2.5)	
					S 254.0(4,7)		107.3(6)	
					μCl 253.5(5)		S S ×1.2(2)[e]	
							C,S 89.5(5.6.0)	
							163.0(4.2.6)	
							C Cl 107.7(5,4.8)	
							169.8(5)	
							S,Cl 78.5(2,5)	

$Br_3SnMo(cp)_2Br$	or	1405(1)	$SnBr_3Mo$	Br	250.7(8.4)	269.1(4)	Br,Br	98.7(2,7)	65
	Pnma	1230(1)					Br,Mo	109.9(2)	
	4	882(1)	$MoC_{10}Br$	C_{cp}	not given			123.0(2,0)	
				Br	250.5(9)		Br,Sn	80.16(2)	
$[Cl_2PhSnMo(CO)_2$	m	1547.9(3)	$SnCl_2CMo$	Cl	238.8(2,10)	269.1(1)	Cl,Cl	97.2(1)	66
$\{S_2P(OEt)_2\}$	$P2_1/n$	1671.8(2)		C_{ph}	212.1(7)		Cl,C	100.2(2,1.6)	
$(S_2C_5Hcy_3)]\cdot CH_2Cl_2$	4	1715.6(4)					Cl,Mo	114.9(1,1.6)	
(green)							C,Mo	124.8(2)	
			MoS_4C_2	S	254.3(2,55)		S,S	72.7(1.4.2)[f]	
				OC	198.0(8,14)			88.1(1,9.7)	
								149.4(1)	
							C,C	101.7(3)	
							C,S	78.0 - 176.3(2)	
							C,Sn	73.2(2,1.0)	
							S,Sn	70.64(6)	
								107.1(1)	
								135.9(1,3.0)	
$ClMe_2SnMo(H)cp_2$	m	884.892)	SnC_2ClMo	C_{Me}	215.3(6,4)	270.0(1)	C,C	105.1(2)	67
	$P2_1/b$	1170.2(2)		Cl	249.9(2)		C,Cl	97.2(2,2.2)	
	1	1472.7(3)	114.59(1)				C,Mo	120.3(2.2)	
							Cl,Mo	111.8(2)	
			$MoC_{10}H$	cp	198.5(5)		$c_{p},_{cp}$	144.6	
				H	164(5)		H,Sn	72.7(2)	
$[Cl_3SnMo(CO)_3(cph)]$	m	867.24(9)	SnC_3Mo	Cl	234.2(2,17)	270.40(7)	Cl,Cl	100.9(1,1.3)	68
(orange)	$P2_1/n$	2154.9(2)	102.099(8)				Cl,Mo	117.6(6,2.2)	
	4	1237.8(1)						no given	
			MoC_3	C_{cp}	233.4(-.31)				
				OC	200.4(7,4)				

$Cl_2BuSnMe(CO)_2$	m	1531.1(6)		$SnCl_2CMo$	Cl	237(2,1)	270.9(7)	Cl,Cl	96.8(4)	69
$\{S_2P(OEt)_2\}$	$P2_1/c$	1023.1(4)	98.76(3)		C_{3u}	213(4)		Cl,C	102(2.4)	
$\{P(OMe)_3\}_2$	4	2088.9(6)						Cl,Mo	114.3(5.2)	
								C,Mo	123(1)	
				$MoC_2S_2P_2$	OC	196(4,2)		C,C	111(2)	
					S	263(2,2)		S,S	75.9(5)	
					P	244(2,9)		P,P	94.7(5)	
$[Cl_3SnMo(NO)$	m	1038.6(1)		$SnCl_3Mo$	Cl	235.2(2,23)	271.5(1)	Cl,Cl	100.2(1,..9)	70
$cp(PPh_3)Cl$	$P2_1/c$	2206.9(3)	89.91(1)					C,Mo	117.6(1,..5)	
(red)	4	2180.9(9)		MoC_3NClP	C_{cp}	234(1,5)		N,Cl	112.3(1)	
					ON	191(1)		N,P	82.4(2)	
					Cl	244.4(2)		Cl,P	92.70(5)	
					P	254.6(1)		N,Sn	79.8(2)	
								Cl,Sn	74.22(4)	
								P,Sn	142.57(3)	
$Cl_3SnMo(C_7H_7)(CO)_2$	or	1181.50(65)		$SnCl_3Mo$	Cl	241.1(5,14)	272.0(1)	Cl,Cl	95.0(1.2.7)	71
	Pnam	943.68(8)						Cl,Mo	121.5(1,2.9)	
	4	1181.50(14)		MoC_9	C	233.7(18,44)		C,C	82.22(4)	
					OC	203.2(11,0)		C,Mo	85.59(33.0)	
$[Cl_3SnMo(NO)(CO)$	m	1549.2(5)		$SnCl_3Mo$	Cl	230.2(4,12)	273.3(1)	Cl,Cl	102.2(2.2.3)	70
$cp(PPh_3)]\ SnCl_3$	$P2_1/c$	1078.7(4)	107.16(3)					Cl,Mo	116.0(2,1.3)	
	4	2180.9(9)		MoC_6NP	C_{cp}	233(1,3)		C,N	107.3(4)	
					OC	195(1)		C,P	79.0(3)	
					ON	182(1)		C,Sn	75.7(3)	
					P	254.9(2)		N,Sn	77.5(3)	
								P,Sn	139.24(6)	

$[Cl_2MeSn(\mu\text{-}Cl)Mo(CO)_3(bpy)]$ (orange)	m	673(1)		SnC_3ClMo	Cl 239.5(6,38)	275.3(3)	Cl Cl	92.7(2,3.1)	72
	$P2_1/c$	1114(1)	90.5(2)		μCl 280.5(4)	61.6(1)		168.1(1)	
	4	2446(3)			C_{Me} 212(2)		Cl,C	97.0(5,8.1)	
							C,Mo	54.8(1)	
								113.3(1,0)	
							C,Mo	126.8(5)	
				MoC_3N_2Cl	O C 198(2,3)		C,C	100.2(6)	
					N_{py} 223(1,0)		N N	72.6(4)[e]	
					μCl 255.7(4)		C Cl	106.9(6,8.9)	
							C N	91.2(5,4.0)	
							C,Sn	70.9(4,7)	
							Cl,Sn	63.6(1)	
$Ph_3SnMocp_2Me$ (orange brown)	m	1009.0(4)		SnC_3Mo	C_{Ph} 217.3(8,4)	275.42(9)	C C	101.6(3,2.1)	73
	$P2_1/n$	1452.2(3)	103.27(3)				C,Mo	116.5(2,2.2)	
	4	1703.5(6)		MoC_{11}	C_{cp} 227(1,5)		cp,cp	138.9	
					C_{Me} 230(1)		C,Sn	79.6(3)	
$Me_3SnMo(H)cp_2$[e] (yellow)	m	894.4(2)		SnC_3Mo	C_{Me} 216.7(3,12)	275.5(1)	C,C	102.0(2.1.3)	67
	$P2_1/n$	1184.5(2)					C,Mo	116.2(2,2.7)	
	8	2627.5(5)	91.86(2)	$MoC_{10}H$	cp 194.5(2)		cp,cp	145.6	
					H 151(6)		H Sn	69.5(3)	
				SnC_3Mo	C_{Me} 217.5(3,16)	275.8(1)	C,C	102.2(2.4)	
							C,Mo	116.0(2,3.1)	
				$MoC_{10}H$	cp 195.5(2)		cp,cp	146.	
					H 160(5)		H,Sn	67.6(3)	
$[(tlp)Mmdcp)Sn Mo(CO)_5]$ (yellow)	tr_	1480.7(2)	108.712(8)	SnC_2Mo	C 218.5(3)	275.6(1)	C,C	91.3(1)	48
	P1	1525.4(2)	106.661(9)		219.3(4)		C,Mo	134.3(1,3)	
	2	1138.6(1)	61.285(7)	MoC_5	O C not given				
$[Ph_3Sn(Mocp)_2$ $\{(CH_2)_2Os(Me_3)\}]$ (orange)	m	2417.9(3)		SnC_3Mo	C_{Ph} 218(1,2)	276.9(1)	C,C	99.3(4.1.6)	73
	$P2_1/a$	913.7(1)	90.286(2)				C,Mo	118.3(3,6.3)	
	4	1606.4(4)		MoC_{11}	C_{cp} 231(1,5)		cp,cp	134.7	
					C_L 228(1)		C,Sn	79.7(3)	

[Cl$_2$BuSn$_2$Mo(CO)$_2$ {P(OMe)$_3$}$_2$Cl]	m P2$_1$/c 4	1471.4(5) 993.1(6) 2164.6(7)	91.12(5)	$SnCl_2CMo$	Cl 239.8(4,12) C_{3u} 213.6(14)	277.4(1)	Cl,Cl 93.9(2) Cl,C 100.3(5,1.7) Cl,Mo 112.5(1,3.1) C,Mo 130.3(4)	74
				MoP_3C_2Cl	P 250.5(4,31) OC 199.0(16,34) Cl 252.5(4)		P,P 88.4(1,7.1) 158.2(1) C,C 105.2(6) P,C 78.0(4,2.3) 111.6(4,9.4) 174.7(4) P,Cl 81.6(1,5.9)	
[Me$_2$ClSnMo(CO)$_3$ {HB(mpz)$_3$}]	m P2$_1$/c 4	1104.4(3) 1206.1(2) 2021.8(4)	100.43(1)	SnC_2ClMo	C_{Me} 213.1(10,2) Cl 239.8(3)	282.27(9)	C,C 111.7(4) C,Cl 101.7(3,9) C,Mo 115.4(3,4) Cl,Mo 108.84(7)	75
				MoN_3C_3	N 224.5(9,1) 226.4(9) OC 193.1(13,29)		N,N 82.9(2,5) C,C 105.1(4,1.6) N,C 83.9(3,7) 162.3(3,1.0) N,Sn 130.1(2,2.1) C,Sn 67.3(2,9)	
[Ph$_3$SnMo(CO)$_2$(cp*) {C(OEt)Ph}] (orange)	m P2$_1$/c 4	1461.1(36) 1678.8(20) 1618.3(30)	96.08(18)	SnC_3Mo MoC_8	CPh 217.0(23) 221.6(18,11) C_{cp} 237.6(29,35) OC 196.4(29,18) C_1 210.5(29)	282.7(6)	C,C 102.6(8,2.2) C,Mo 115.7(5,1.5) C,C 79.4(12,1.6) 108.8(12) C,Sn 71.1(9,2)	76
[Me$_3$SnMo(CO)$_3$(ab)] (yellow)	or P4$_2$/n 8	2353.4(4) 694.6(1)		SnC_3Mo MoC_6NB	C_{Me} 214.1 OC 196.5 C_{ab} 232.1(6,55) N 231.9(4) B 249.5(7)	282.9(1)	C,Mo 110.9 C,C 81.5(2,8) 100.5(2) C,Sn 69.8(2,0) 134.0(2)	59

$[Ph_3Sn_1Mo(CO)_3(HBpz_3)]$ (yellow)	m	1757.0(2)		SnC_3Mo	C_{Ph} 213.6(12,10)	286.44(1)	C,C	104.7(4,1.2)	75
	$P2_1/n$	1407.7(2)	96.985(8)				C,Mo	113.9(3,1.6)	
	4	1218.0(1)		MoN_1C_3	N 220.8(9)		N,N	82.0(3,5)	
					221.8(9,1)		C,C	106.3(5,2.7)	
					OC 198.3(14,11)		N,C	84.3(4.2.6)	
								161.7(4,1.8)	
							N,Sn	130.8(3,1.7)	
							C,Sn	67.5(3,5)	
$[Ph_1Sn_1Mo(NO)_1(CO)_2(PMe_2Ph)_2]$ (yellow)	m	1051.5(1)		SnC_3Mo	C_{Ph} 218.0(3,7)	289.89(5)	C,C	100.7(1,5.1)	77
	$P2_1/n$	2519.0(4)	95.15(1)				C,Mo	not given	
	4	1276.1(2)		MoC_2P_2N	OC 204.4(4,1)		C,C	116.9(1)	
					ON 180.6(3)		P,P	176.19(3)	
					P 250.5(1,6)		C,P	89.9(1,4.9)	
							C,N	96.5(1,8)	
							P,N	90.4(1,1)	
$[Cl_2BuSn(\mu\text{-}\eta^3\text{-}S_2CPcy_3)(\mu\text{-}Cl)Mo(CO)_2(Pcy_3)]$ CH_2Cl_2 (red)	tr	1054.8(2)	88.72(2)	$SnCl_3S_2C$	Cl 241.4(5.7)	363.6(2)	Cl,Cl	168.9(2)	78
	P1	1448.3(3)	79.55(1)		μCl 276.2(4)		Cl,C	95.9(7,8.3)	
	2	1898.2(3)	80.15(2)		μS 262.9(4.91)		Cl,S	153.5(1)	
					C_{Bu} 213(2)		C,S	164.1(6)	
				MoC_3S_2CP	OC 194(2.1)		C,C	118.2(6)	
					μCl 216(1)		C,Cl	103.2(4.6.5)	
					μS 253.7(4.42)		C,P	118.2(5,18.0)	
					μCl 256.0(4)		C,S	109.6(5,1.3)	
					P 256.2(4)			159.1(5)	
							S,Cl	83.1(1,7)	
							S,P	100.6(1)	
								164.3(1)	
							Cl,P	84.0(1)	
$[Ph_2Sn(\mu\text{-}cp)Mo(CO)_2(CPh_3)]$	tr	990.8(12)	87.92(7)	SnC_4	C_{Ph} not given		not given		79
	P1	1180.3(9)	74.34(8)		C_{cp} not given				
	2	1426.8(12)	68.83(8)	MoC_8	C_{cp} not given		not given		
					OC 196.3(21,1)				
					C_{Ph} 181.0(14)				

$[Ph_2Sn(\mu\text{-cp})Mo(CO)_2(\eta^3\text{-PhCHOEt})]$	m	993.4(6)		SnC_4	C_{Ph} not given		not given		79
	$P2_1/c$	992.5(6)	94.97(6)		C_{cp} not given				
	4	3072.4(5)		MoC_{10}	C_{cp} not given		not given		
					OC 150.1(17,28)				
					C_L 236.9(19,59)				
$[Cl_2\{(Me_3Si)_2CH\}Sn W(H)cp_2]$ (orange)	m	1018.1(9)		$SnCl_2CW$	Cl 242.3(3,19)	270.6(1)	Cl,Cl 93.5(1)		80
	$P2_1/c$	1785.8(9)	92.46(5)		C 218.0(8)		Cl,C 103.8(2,1.1)		
	4	1256.6(9)					C,W 113.6(1,4.0)		
							C W 123.7(2)		
							cp,cp 144.7		
				WC_{10}	C_{cp} 228(2,4)		cp,Sr 103.0(-,8)		
$[Cl_2(thf)Sn W(CO)_5]$ (yellow)	tr_	666.8(2)	70.49(2)	$SnCl_2OW$	Cl 236.3(3,12)	271.1(1)	C,Cl 98.3(1)		81
	P1	979.1(4)	89.03(1)		O_{thf} 222.3(6)		Cl,O 87.8(2,5)		
	2	1258.3(2)	77.67(2)				C,W 129.1(1,6.3)		
							C W 108.3(2)		
				WC_5	OC 197.8(10)		C C 90.0(3,1.6)		
					204.6(9,28)		C,Sn 90.0(3,3.8)		
							174.3(3)		
$[Cl_2(thf)_2Sn W(CO)_5]$ (yellow)	tr_	958.9(9)	69.05(6)	SnO_2Cl_2W	Cl 236.8(2,4)	273.7(1)	Cl,Cl 101.8(1)		81
	P1	1070.4(5)	86.03(7)		O_{thf} 235.3(8,3)		O,O 160.1(2)		
	2	1085.6(8)	66.41(6)				Cl,O 83.7(2,1.5)		
							Cl,W 129.0(1,5.7)		
							O W 99.9(1,2.4)		
				WC_5	OC 198.9(8)		C C 90.0(4,2.0)		
					203.9(11.7)		C Sn 90.0(2,5.1)		
							174.5(2)		
$[(dmamp)_2Sn W(CO)_5]$ (colourless)	m	1310.2(4)		SnN_2C_5W	N 256.4(4,0)	274.9(1)	N N 140.9(2)		82
	C2/c	1552.1(4)	90.11(4)		C 216.4(4.0)		C,C 117.4(2)		
	4	1202.9(4)					N C 72.5(2,0)[e]		
							87.3(2,1)		
							N W 109.6(1)		
							C,W 121.3(1)		
				WC_5	OC 198.7(8)		C C 91.5(3,2.8)		
					203.8(7,14)		175.3(3,1.6)		
							C Sn 87.7(2,8)		
							180.0(1)		

[(tbp) (mdbp)Sn	tr	1475.0(2)	108.56(1)	SnC_2W	C	217.8(4)	275.1(1)	C C 91.5(2)	83
$W(CO)_5$]	P1	1521.5(2)	106.47(1)			219.1(5)		C W 129.2(1.4.8)	
(pale yellow)	2	1134.9(1)	61.36(1)	WC_5	OC	203.2(8,26)		not given	
$[Cl_2(Me)SnW(Cl)$	m	745.8(3)		$SnCl_2CW$	Cl	238.3(12,4)	275.9(3)	C,Cl 97.2(4)	84
$(CO)_3(dth)]$	$P2_1/c$	1504.4(9)	110.75(2)		C_{Me}	212.(5)		C,C 103.5(13,2.2)	
(orange)	4	1622.8(12)						C,W 112.6(3,2.0)	
								C W 123.8(12)	
				WC_3S_2Cl	OC	196(4.4)		C,C 76.8(13,2.2)	
					S	255.8(8,22)		106.0(13)	
					Cl	251.7(10)		S,S 80.6(3)[e]	
								C,S 89.7(10,12.0)	
								148.5; 175.2(10)	
								S,Cl 81.7(3,5.3)	
$(dppmp)SnW(CO)_5$	m	2108.1(4)		SnC_2PW	C	218.3(7.2)	276.2(1)	C C 106.5(3)	82
(colourless)	$P2_1/n$	1707.7(4)	97.47(2)		P	283.1(2)		C P 78.6(2,5.0)	
	4	1283.7(3)						C W 126.6(2,1)	
								P,W 114.1(1)	
				WC_5	OC	199.0.8)		C C 90.3(3,1.4)	
						202.8,9,17)		178.6(3,2)	
								C W 89.3(2,1.6)	
								177.7(2)	
$[Cl_2(EtOH)SnW(CO)_3$	m	1689.7(2)		SnO_2Cl_2NW	O	not given	277.67(9)	171.7 - 95.6(1)	68
(cpdh)] EtOH	Cc	1378.0(1)	116.08(1)		N	223.7(9)		173.7 - 163.4(3)	
(orange)	4	1245.9(2)			O_{Et}	not given			
					Cl	244.9(4,5)			
				WC_3	C_{cp}	233.4(-,32)			
					OC	200.4(7,4)			
$(NEt_4)[Ph_3Sn$	m	1965.5(5)		SnC_3W	C_{Ph}	219.8(5,14)	280.7(1)	C C 98.4(3,7)	85
W (PhCCPh)$_3$]	$P2_1/n$	1266.2(3)	111.07(2)					C W 118.9(2,8.3)	
	4	2408.4(7)		WC_5	C	206.1(7,23)		C C 36.8(2,2)[g]	
								106.6(3,18.5)	

(ppm) $[Ph_3Sn\ W(CO)_5]$	m	1067.6(2)		SnC_3W	C_{Ph} 220.2(5,7)	281.2(1)	C,C 100.5(2,3.7)	86
(light yellow)	$P2_1/n$	1504.8(3)	81.46(2)				C,W 117.4(2,5.3)	
at 173K	4	3242.3(7)		WC_5	OC 197.0(9)		C,C 91.2(4,3.7)	
					203.1(11,20)		174.2(4,2.4)	
							C Sn 87.6(3,5.1)	
							178.2(3)	
$Ph_3SnW(NO)(CO)_2$	or	1331.1(6)		SnC_3W	C_{Ph} 217.1(8,5)	281.3(1)	C C 102.6(3,3.2)	57
$(MeCN)_2$	$P_{na}2_1$	1219.4(4)					C,W 115.6(2,2.3)	
	4	1527.8(5)		WN_3C_2	O N 188.8(8)		N N 90.4(3,6.8)	
					CN_{Me} 215.2(8.3)		173.0(3)	
					O C 191.5(8,13)		C,C 93.5(3)	
							N C 91.5(3,2.7)	
							171.2(3)	
							N Sn 85.6(2,1.9)	
							C Sn 90.3(2)	
							176.2(2)	
$(dman)_2SnW(CO)_5$	tr	1250.9(3)	98.42(1)	$SnNC_2W$	N 258.7(5,1)	282.2(2)	N N 150.7(2)	87
(pale yellow)	P1	1519.1(1)	104.33(1)		C 218.3(5,11)		C C 102.6(3)	
	2	978.0(1)	107.27(1)				N C 71.4(3,2)[a]	
							90.1(3,1)	
							N W 104.6(2,9)	
							150.7(2)	
				WC_5	O C not given		C W 127.8(2,1.1)	
(ppm) $[Ph_3SnW(CO)_3$	m	4577.7(4)		SnC_3W	C_{Ph} not given	282.5(1)	C C 103.5(24)	88
$(C_2B_9H_{11})]$	C2/c	1166.9(1)	125.134(2)				C W 114.5(33)	
(pale yellow)	8	2682.6(3)		WC_5B_3	O C 195.7(15)		C C 77.2(6,1)	
					C 232.9(19,26)		105.8(6)	
					B 239.5(23,21)		C,Sn 71.0(5,1)	
$[Ph_3Si\ W(CO)_3$	m	1037.2(1)		SnC_3W	C_{Ph} not given	282.73(7)	not given	89
$\{Ph_2CH_2N(Me)$	$P2_1$	1793.7(2)	92.838(4)	WC_4N_2	O C not given		C C 170.3(4)	
$CH_2CH_2Nme_2\}]$	2	1161.9(2)			L,C 2.20(1)		C N 80.4(4,4.8)	
(yellow)					N 2.30(1,7)		160.2(4,4.5)	
							N,Sn 125.5(3)	

$[Ph_3SnW(CO)_2cp$	m	1925.8(8)		SnC_3W	C_{Ph} 218.3(5.6)	283.7(1)	C,C not given	90
(4-MeC$_6$H$_4$CH)]	C2/c	853.7(2)	97.05(4)				C,W 112.3(1,2.5)	
(yellow)	8	3406(2)		WC_3	OC 198.9(7,2)		C,C 80.6(3,2)	
					C_L 203.2(7)		97.4(2)	
					cp 237.1(5)		C,Sn 72.0(2)	
							137.8(2)	
$[Ph_2Sn(\mu$-FhCH$_2$S CS)	tr_	1278.0(4)	102.43(4)	SnC_4	C_{Ph} 213.2(6,5)		C,C 108.7(2,4.6)	91
$W(CO)_5]$	P1	1303.4(4)	93.18(4)		μC_L 218.5(5)			
(red)	2	1068.1(3)	115.05(4)	WC_5S	OC 196.6(5)		C,C 177.7(3,1.0)	
					202.4(7,23)		C,S 91.0(2,8.1)	
					μS_L 250.2(1)		172.4(1)	
[(tb) (tip) Sn(μ-S$_t$)	m	1734(5)		SnC_2S_2	C_{tb} 217(2)		C C 118.1(9)	92
$W(CO)_5]$	$P2_1/c$	1109(1)	?		C_{tip} 211(3)		S S 93.9(3)°	
	4	3298.5(5)			μS_L 248.5(8,11)		C S 110.8(7,11.6)	
				WC_5S	OC 190(5,1)		not given	
					203(4,3)			
					μS_L 251.9(9)			
$[ClSn\{\mu$-OP(OEt)$_2$	m	2006.4(6)		SnO_2Cl	μO_L 214.5(10,5)		O O 87.0(4)	93
$PP(OEt)_2O\}$ $W(CO)_5]$	$P2_1/a$	772.9(2)	93.81(2)		Cl 247.0(5)		O Cl 91.1(3,1.6)	
	4	1651.1(5)		WC_5P	OC 192(2)		C C 90.0(8.1.8)	
					204(2,8)		176.6(8.1)	
							C,P 90.0(6,3.8)	
							176.3(6)	
$Ph_3Sn(\mu$-cp)W	tr_	1007.3(14)	87.83(5)	SnC_4	not given		not given	79
$(CO)_2(PhC)$	P1	1182.6(9)	74.10(8)	WC_3				
	2	1423.3(8)	65.54(8)					
$[Na(12$-crown-$4)_2]$	tr_	1524.6(6)	95.16(3)	SnS_3Mn	S_{mes} 249.4(5,8)	250.8(3)	S,Mn 121.0(1,7.8)	94
$[(mesS)_3SnMo(CO)_2$	P1	1842.2(6)	97.37(3)	MnC_7	not given			
$(cpMe)]^e$	4	1973.8(7)	96.46(3)	SnS_3Mn	S_{mes} 248.9(5,12)	251.3(3)	S,Mn 120.1(2,7.3)	
$[Cl_3SnMo(CO)_3$	m	998.1(2)		$SnCl_3Mn$	Cl 236.5(3,9)	254.7(1)	not given	95
$(S_2CPcy_3)]$ CH_2Cl_2	$P2_1/n$	1825.6(2)	104.76(3)	MnC_3S_2	OC 179(1,0)		C C 91.2(5,.9)	
(purple red)	4	1919.5(4)			S_L 235.5(3,7)		S S 72.9(1)	
							C,S 169.3(3.8)	
							C,Sn 89.6(3,2.0)	
							175.8(13)	
							S,Sn 86.8(1,2.2)	

$Cl_3SnMn(CO)_5$[c]	m	1410(1)		$SnCl_3Mn$	Cl	230.2(12)	257.5(5)	Cl,Cl	100.4(4,7)	96a
(pale yellow)	$P2_1/c$	1338(5)	97.39(21)			235.4(11,5)		Cl,Mn	117.5(2,2.5)	
	8	1327(2)		MnC_5	OC	181.5(52,11)		C,C	90.6(2.1,3.3)	
						191.6(47,57)			177.3(22,1.1)	
								C,Sn	88.7(1.6,1.7)	
									179.0(14)	
				$SnCl_3Mn$	Cl	234.8(12,14)	260.4(5)	Cl,Cl	100.9(4.6)	
								Cl,Mn	117.2(3,4)	
				MnC_5	OC	184.0(36,9)		C,C	91.3(1.6,3.5)	
						189.2(35.21)			174.2(15,1.3)	
								C,Sn	86.8(12,2.2)	
									178.2(12)	
$[Cl_3SnMn(CO)$	m	1301.8(6)		$SnCl_3Mn$	Cl	230.5(4,8)	258.9(2)	Cl,Cl	103.7(2.2.2)	96b
$(PPh_3)cp]\ SnCl_5$	$P2_1/c$	1939.6(8)	104.84(4)					Cl,Mn	114.7(1.6)	
(red)	4	1329.3(6)		MnC_7P	OC	182(1,1)		C,C	115.1(1)	
					C_{cp}	217(1,2)		C,P	79.8(4,2)	
					P_{Ph}	236.7(4)		C,Sn	74.6(3.3)	
								P,Sn	131.1(1)	
$[Ph_3SnMn(CO)_4$	m	1045(1)		SnC_3Mn	C_{Ph}	217(4,1)	262.7(10)	C,C	105(-,3)	97
$(PPh_3)]$	$P2_1/n$	2648(4)	99.34(3)					C,Mn	114(-,2)	
	4	1265(2)		MnC_4P	OC	179(4,6)		C,C	90(-,7)	
					P_{Ph}	226.7(19)		C,P	93(-,4)	
								C,Sn	86(-,6)	
								P,Sn	176	
$[Ph_3Sn(\mu\text{-}H)Mn$	$P\bar{1}$	826.2(3)	94.63(3)	SnC_3HMn	C_{Ph}	215.3(4.8)	263.6(1)	C,H	98(1,9)	98
$(CO)_2(cpMe)]$	$P\bar{1}$	1053.6(4)	99.95(3)		μH	216(4)			137(1)	
(colourless)	2	1475.5(6)	110.58(3)					C,Mn	112.4(1.2.5)	
								H,Mn	31(1)	
				MnC_7H	OC	175.7(5,1)		C,C	87.9(2)	
					C_{cp}	212.9(6,9)		C,H	73; 114(2)	
					μH	137(4)		C,Sn	77.8; 110.6(2)	
								H,Sn	55(2)	

$[Me_2(Br)SnMn(CO)_3(PPh_3)_2]$ (yellow)	m	2375.1(5)		SnC_2BrMn	C_{Me}	215.6(38)	265.9(6)	C,C 102.0(13)	99
	$P2_1$	1627.9(2)	98.03(2)			223.4(26)		C,Br 99.8(12,2.9)	
	4	1030.6(3)			Br	257.1(5)		C,Mn 119.7(13,2.5)	
								Br,Mn 112.3(2)	
				MnC_3P_2	OC	157.8(45)		C,C 156.8(18)	
						179.7(26,15)		P,P 168.7(4)	
					P_{Ph}	227.1(9)		C,Sn 78.5(16,3.7)	
						236.4(9)		167.2(8)	
								P,Sn 95.6(3,2.3)	
$Ph_3SnMn(CO)_5$	m	1591(1)							100
	C2/c	1632(1)	95.0(1)						
	2	3212(2)							
$Ph_3SnMn(CO)_5$[h]	m	1217		SnC_3Mn	C_{Ph}	208.0(48)	267.0(7)	C,C 106.6(1.9,1.9)	101
	$P2_1$	3222	90.33			216.7(48,2)		C,Mn 112.2(1.3,1.3)	
	8	1139		MnC_5	OC	175.7(43,39)		C,C 91.8(2.7,5.3)	
								172.1(2.7.7)	
								C,Sn 86.1(1.4,3.5)	
								179.2(1.4)	
				SnC_3Mn	C_{Ph}	213.1(48.2)	267.2(7)	C,C 105.1(1.9,2.0)	
						216.6(48)		C,Mn 87.2(1.4,1.9)	
				MnC_5	OC	175.4(43,115)		C,C 91.3(2.7,4.1)	
								C,Sn 87.2(1.4,2.3)	
				SnC_3Mn	C_{Ph}	216.1(48)	267.6(7)	C,C 105.0(1.9,1.9)	
						217.8(48,4)		C,Mn 12.7(1.3,1.5)	
				MnC_5	OC	175.0(43,75)		C,C 91.9(2.7,5.5)	
								C,Sn 86.0(1.4,1.9)	
				SnC_3Mn	C_{Ph}	213.0(48,10)	267.8(7)	C,C 105.3(1.9,3)	
						222.1(48)		C,Mn 113.4(1.3,1.5)	
				MnC_5	OC	178.6(43,54)		C,C 91.1(2.7,3.1)	
								C,Sn 87.6(1.4,2.1)	
$Me_3SnMn(CO)_5$	m	701.8(9)		SnC_3Mn	C_{Me}	205.8(15)	267.4(2)	C,C 107.3(6.4)	102
	$P2_1/n$	1338.9(17)	114.30(3)			216.6(16,4)		C,Mn 111.6(4.6)	
	4	1456.2(20)		MnC_5	OC	180.6(12,48)		C,C 92.5(6.4.1)	
								C,Sn 84.4(4,2.0)	

$[Ph_3SnMn(CO)_3$	m	2002.5(1)		SnC_3Mn	C_{Ph} not given	270(1)	not given	103
$(Bu^tN(CH_2)_2NBu^t)]$	$P2_1/c$	1891.7(1)	112.120(1)					
	8	1711.7(1)		MnC_3N_2	OC 185(1)		not given	
					L,N 210(2.0)			
$[Ph_3Sn\{\mu\text{-}OC_5(Ph)_4\}$	m	1049(2)		SnC_3O	C_{Ph} 208.7(14)		C,C 114.6(5.2.2)	104
$Mn(CO)_3]$	$P2_1/n$	1758(3)	90.15		215.2(15,18)		C,O 103.7(5,4.2)	
	4	2211(4)			μO_L 201.0(9)			
				MnC_3	OC 175.1(17,16)		C,C 91.1(7,1.4)	
					L,C 215.0(13,30)			
					221.1(13)			
$[Ph_3Sn\{\mu\text{-}EtOC(O)CH$	tr	1143.1(4)	115.32(3)	SnC_4	C_{Ph} 214.0(1)		not given	105
$ChC(O)OEt\}Mn$	P1	1222.1(4)	95.451(3)		μC_L 215.5(2)			
$(CO)_4]$	2	1331.4(5)	108.44(3)	MnC_5O	OC not given		C,C 93.1(2)	
					μC_L 203.8(2)		169.5(1,5)	
					O 205.7(3)		C,O 78.1(1)	
							174.9(1)	
$[Cl_3Sn(\mu\text{-}OH)(\mu\text{-}dmg)_2$	tr_	1147.1(1)	65.13(2)	SnO_2Cl_3	μHO 210.3(5)	347	not given	106
$Tc(dmg)_2]\cdot 3H_2O$	P1	1192.1(2)	80.02(2)		μO_L 2.06.8(8,1)	114.2(2)		
(yellow)	2	1081.1(2)	73.55(5)		Cl 238.4(4,29)			
				TcN_6O	μHO 203.0(6)		not given	
					N 208.9(9,15)			
$Cl_3SnReCp_2$	m	625.8(2)		SnC_3Re	Cl 237.4(4.4)	260.9(1)	Cl,Cl 96.3(2,1.7)	107
(red)	$P2_1/b$	1298.7(4)					Cl,Re 120.6(1,3.6)	
	4	1620.7(4)	92.41(2)	ReC_{10}	C_{cp} 223(1)		cp,cp 148.0	
							cp,Sn 106.0(-,1)	
$Cl_2MeSnReCp_2$						263(1)		107
(yellow)								
$ClMe_2SnReCp_2$	m	884.1(3)		SnC_2ClRe	C_{Me} 214(2.0)	265.5(1)	C,C 103.4(5)	107
(yellow)	$P2_1/b$	1116.5(4)			Cl 245.1(5)		C,Cl 95.9(5,2.2)	
	4	1487.6(4)	113.66(3)				C,Re 123.4(4,2)	
							Cl,Re 107.5(1)	
				ReC_{10}	C_{cp} 223(1)		cp,cp 150.8	
							cp,Sn 104.5(-.2)	

$[Ph_3SnRe(CO)_4$	tr	1122.5(2)	86.29(2)	SnC_3Fe	C_{Ph} 216.7(5.11)	279.3(1)	C C	102.7(2.3.1)	108
{p-Me_2N-C_6H_4COE}]	$P\bar{1}$	1188.4(3)	96.80(2)				C R$_3$	115.5(1,2.9)	
(yellow)	2	1263.3(2)	104.53(2)	R$_3$C$_5$	OC 197.1(6,28)		C,C	91.0(2.5.1)	
					C_L 216.6(5)			174.3(2)	
							C,S$_1$	87.0(2,5.4)	
								176.9(2)	
$[Ph_3Sn(\mu\text{-}\eta^3\text{-}CO_2)$				SnC_3O_2	C_{Ph} 213.7(10.20)		C C	107.9(4,.0)	109
Re(NO)(cp*)(PPh$_3$)]					μOCO 217.5(7)		O,O	57.8(2)[8]	
(yellow)					225.7(7)		C O	95.7(3.8.4)	
								138.3(3,6.1)	
				ReC$_5$NP	μO_2C 205.8(9)		C,N	94.2(4)	
					C_{cp} not given		C,P	87.7(3)	
					ON 175.1(7)		N,P	93.7(3)	
					P_{Ph} 235.5(3)				
$[Ph_3Sn(\mu\text{-}\eta^3\text{-}CO_2)$	m	1964.4(8)		SnC_3O_2	C_{Ph} not given		O O	56.79(5)[8]	110
Re(NO)(CO)(cp*)]	$P2_1/a$	1181.9(9)	100.16(5)		μOCO 209.2(3)				
(orange)	4	1217.1(8)			239.9(1)				
				ReC$_3$N	μO_2C 210.0(9)				
					C_{cp} not given				
					ON not given				
[(4-Me-2,6-	m	1934.2(3)	94.38(1)	SnO$_3$Fe	O 196.4(5)	240.8(1)	O,O	92.2(2)	111
$Bu^t_2C_6H_2O)_2$	I2/c	960.0(1)			198.3(5)		O,Fe	133.9(1,1.0)	
$SnFe(CO)_4$]	8	3817.6(1)		FeC_4	OC 180.8(1,2)		C,C	89.8(4,6)	
								123.2(4)	
								179.0(4)	
							C,Sn	104.3(3,16.5)	
$Br_3SnFe(CO)_2cp$	or	1258.4(1)		$SnBr_3Fe$	Br 249.1(2)	246.2(2)	B-Br	117.7(1.7)	112
	Pbca	1342.8(1)			250.6(2.2)		B-Fe	100.2(1,1.6)	
	8	1515.9(2)		FeC_7	OC 175.7(13,.1)		C,C	96.0(6)	
					C_{cp} 209(2.2)		C,Sn	90.2(4,2.3)	
							c_p,Sn	121.9(1)	
$Cl_3SnFe(CO)_2cp$	tr	1101.8(2)	106.24(1)	$SnCl_3Fe$	Cl 236.0(2.13)	246.7(1)	C,Cl	98.3(1,2.2)	113
(yellow)	$P\bar{1}$	835.7(1)	84.77(1)				C,Fe	119.2(1,2.9)	
	2	662.7(1)	96.39(1)	FeC_7	OC 178.5(5.0)		C,C	94.9(3)	
					C_{cp} 209.2(7,17)		C,Sn	90.5(2,6)	
							C_p,Sn	123.6(2)	

$Cl_2(Ph)SnFe(CO)_2cp$	m	1494.0(2)		$SnCl_2CFe$	Cl 238.4(4,2)	246.7(2)	Cl,Cl 99.1(1)	114a
(pale yellow)	$P2_1/c$	850.3(1)	102.98(1)		C_{Ph} 212.6(13)		Cl,C 100.2(4.3)	
	4	1258.2(2)					Cl,Fe 111.5(1,1.4)	
							C,Fe 129.7(3)	
				FeC_7	OC 175.0(14.5)		C,C 94.1(6)	
					C_{cp} 208.6(14.42)		C,Sn 91.8(4,6)	
							cp,Sn 118.9(5)	
$I_2SnFe(CO)_2cp$	or	1289.4(3)		SnI_3Fe	I 271.4(2,20)	Fe 248.0(3)	I,I 100.9(1,2.3)	114b
(orange red)	Pbca	1435.1(2)					I,Fe 117.1(1,2)	
	8	1550.9(3)						
$[(2,4,6\text{-}Bu^t_3C_6H_2)_2Sn$	tr_	917.34(5)	89.904(5)	SnC_2Fe	L,C 218.6(4,6)	248.4(1)	C,C 100.5(2)	114c
$Fe(NO)_2(CO)]$	P1	1179.26(7)	83.017(5)				C,Fe 129.7(1,2.8)	
(dark red)	2	2166.3(1)	82.118(2)	FeN_2C	ON 165.8(5,1)		not given	
					OC 179.1(8)			
$[Me_2(tfo)SnFe(CO)(cp$	m	1601.0(2)		SnC_2ONFe	C_{Me} 214.0(5,5)	248.8(1)	C,C 109.5(3)	115
)	$P2_1/c$	785.2(2)	110.35(1)		O_{tfo} 234.3(3)		C,Fe 124.8(2,1.6)	
$\{\mu\text{-}MeP\text{-}(N(H)CH_2)_2\}]$	4	1842.0(3)			μN_L 269.5(4)		O,Fe 89.0(1)	
(yellow)							N,Fe 77.0(1)	
				FeC_5P	OC 173.8(5)		C,P 94.2(2)	
					C_{cp} not given		C,Sn 88.0(2)	
					μP_L 214.0(2)		P,Sn 81.0(1)	
(oep) $Sn_2Fe_2(CO)_4$	tr_	1225.3(4)	59.53(3)	SnN_4Fe	N_{oep} 218.8(4,17)	249.2(1)	N,Fe 112.0(1,1.8)	116
	P1	1391.0(5)	61.14(3)					
	2	1508.7(5)	68.88(3)	FeC_4	OC 175.4(6,13)		C,Sn 87.1(1,9)	
							179.1(1)	
$[Me_2Sn_2Fe(H)_3$	c_	2835.7(3)		SnC_3Fe	C_{Me} not given	250.8(1)	not given	117
$(PbuPh_2)_3]$	I43d			FeH_3P_3	P 222.7(4)		P,P 103.5	
(yellow)	16						P,Sn 114.9(1)	
$Ph_2Sn(\mu\text{-}H)_3Fe$	m	1310(8)		$Sn_2H_3C_3Fe$	μH 165	252.7(1)	C,Fe 116.2(2.4.1)	118
$(PbuPh_2)_3$	$P2_1/c$	1199(8)	90.65(1)		C_{Ph} not given	100		
(yellow)	4	2221(3)		FeH_3P_3	μH 165		P,P 102.8(1,1.0)	
					P 223.9(2,8)		P,Sn 115.5(1,3.2)	
$[Me\{Me_2Si(Nbu^t)_2\}$	or	1787.1(9)		$SnNCFe$	C_{Me} 214.8(9)	253.2(2)	N,C 113.5(2)	119
$SnFe(CO)_2cp]$	Pnma	1299.8(7)			L,N 206.5(4)		N,Fe 117.4(1)	
	4	983.8(5)					C,Fe 87.6(2)	
				FeC_7	OC 173.4(5)		not given	
					C_{cp} 208.7(9,8)			

[{(Me$_3$Si)$_2$NCH$_2$}$_3$C	or	1622.4(3)	SnN_3Fe	N 206.7(6.4)	253.9(1)	N N 94.0(2,1.7)	120
Me$_3$SnFe(CO)$_2$cp]	Pbcn	1951.1(4)				N,Fe 122.3(2,5.9)	
(yellow)	?	1873.9(4)	FeC_7	OC 175.6(8,6)			
				C_{cp} not given			
[Ph$_3$SnFe(CO)$_2$	m	1126(2)	SnC_3Fe	C_{Ph} 216(2,2)	254.3(2)	C,C 104.9(7,1.1)	121
{1,3-(Me$_3$Si)$_2$C$_5$H$_3$}]	$P2_1/n$	1307.7(6)	101.8(2)			C,Fe 113.7(4,3.6)	
	4	2101.7(4)	FeC_7	OC 172(2,1)		C,Fe 85.7(6,1)	
				L,C 211(2,4)			
(NEt$_4$) [Ph$_3$SnFe (CO)$_2$	tr	1120.9(1)	79.959(3)	SrC_3Fe	C_{Ph} 217.9(2,7)	255.4(1)	C C 104.9(1,3.5)	122
$(C_2B_9H_{11})$]	P1	1302.6(1)	84.143(3)				C,Fe 117.0(1,6.6)	
(orange)	2	1359.5(1)	66.060(2)	FeC_4B_3	OC 174.3(4,13)		C,Sn 89.3(1,10.6)	
					L,C 209.5(3.4)		143.6(1)	
					B 216.7(4,14)		B Sn 94.7(1,14.1)	
							158.4(1)	
[Ph$_3$SnFe(CO)	m	1105.0(3)	SnC_3Fe	C_{Ph} 221	256	not given	123
(cp) (PhCCPh)]	$P2_1/c$	1567.6(1)	92.0(1)					
	4	1788.1(4)	FeC_8	OC 178		not given		
				C_{cp} 215				
				L,C 203(-,2)				
Me$_3$SnFe(CO)	tr	1083.1(1)	101.48(2)	C_{Me} 211(3)	256.2(4)	C,C 102.3(2,3.1)	124
(cp) ($f_6$fos)	P1	2238.2(4)	93.13(2)	215(3,0)		C,Fe 116.0(8,7.7)	
	4	1545.9(2)	83.26(2)	OC 163(3)		C,P 95.1(1(!)	
			FeC_6P	C_{cp} 210(3.5)		C,Sn 82.5(9)	
				L,P 217.5(8)		P,Sn 97.1(2)	
						cp,Sn 115.4(10)	
[Bu$_2$SnFe(CO)$_3$	m	2027.1(4)	SnC_2OFe	C_{Bu} 209.1(8,20)	256.7(3)	C,Fe 120.0(2,4.5)	125
{μ-P(Ph$_2$)C(H)-	$P2_1/n$	1824.2(3)	105.21(2)	μO_L 207.5(7)		O,Fe 101.8(2)	
C(Ph)O}{(MeO)$_2$Si}]	4	1069.5(3)	FeC_3PSi	OC 177.3(8,26)		P,Sn 90.8(1)	
(yellow)				μP_L 228.7(4)		Si,Sn 83.9(1)	
				Si_L 231.7(4)			

[Ph_2(Cl)SnFe	m	2128.5(4)		SnC_2ClFe	C_{Ph} 214.1(3,1)	257.7(1)	C,C 111.8(1)	126
$(CO)_3(NO)$]^c	C2/c	1166.6(3)	96.17(1)		Cl 237.7(1)		C,Fe 114.0(1,4)	
(crange)	16	2835.4(6)					Cl,Fe 108.82(3)	
				FeC_3N	OC/N 177.4(4)		N/C,Sn 84.4(1,2.6)	
					OC 183.4(4)		178.2(1)	
				SnC_2ClFe	C_{Ph} 214.0(3,6)	258.7(1)	C,C 114.4(1)	
					Cl 238.7(1)		C,Fe 114.5(1,9)	
							Cl,Fe 106.18(3)	
				FeC_3N	OC/N 177.4(4)		N/C,Sn 83.6(1,2.8)	
					OC 183.6(4)		175.7(1)	
[$Ph_2SnFe(CO)_3$ (Ph)	or	1353.8(3)		SnC_3Fe	C_{Ph} 217(2,1)	259.9(2)	not given	127
{μ-P(Ph_2)CH_2 CH_2}]	$P2_12_12_1$	1391.7(5)			μC_L 216(2)			
(pale yellow)	4	1653.7(4)		FeC_4P	OC not given		C,Sn 85.5(4,6.7)	
					C_{Ph} 209(1)		173.1(5)	
					μP_L 226.5(4)		P,Sn 85.3(1)	
							C,C 90.7(6,5.0)	
							160.1(5)	
$Ph_3SnFe(CO)_3(NO)$	tr	1008.9(1)	94.89(1)	SnC_3Fe	C_{Ph} 214.0(4.4)	261.9(1)	C,C 109.2(1)	126
(orange)	P1	1050.1(1)	110.66(1)				C,Fe 109.8(1)	
	2	1098.9(1)	82.00(1)	FeC_3N	OC/N 175.9(4)		N/C,Sn 82.8(1)	
					OC 183.2(5)		179.4(2)	
[$Me_3SnFe(CO)_3$	m	1483.0(3)		SnC_3Fe	C_{Ph} not given	262.43(21)	not given	128
{$Me(CH_2)_3Ph$}]	$P2_1/n$	756.51(18)	102.00(13)	FeC_5	OC 178.0(15,20)		C,C 95.9(6,13.6)	
	4	1572.02(18)			C_L 208.3(13)		123.7(6)	
					220.4(14.6)		157.5(5,2.1)	
							C,Sn 88.9(5.13.7)	
							131.6; 163.7(4)	
[$Ph_3SnFe(CO)$ (cp)	m	1234.0(3)		SnC_3Fe	C_{Ph} not given	not given	not given	129
{C(OCOMe)Ph}]	$P2_1/n$	1671.4(5)	92.44(3)					
	4	1374.4(5)		FeC_7	C_L 179.8(5)		not given	
[$Ph_3SnFe(CO)$(cp)	m	1209.0(2)		SnC_3Fe	C_{Ph} not given	not given	not given	129
{C(OCOPh)Ph}]	$P2_1/c$	1857.2(5)	112.03(1)					
	4	1529.0(4)		FeC_7	L,C 179.8(9)		not given	

[Ph$_2$Sn(μ-C≡C)Fe(cp)(cppm)] (red)	m $P2_1/n$ 4	1069.3(2) 1979.4(3) 1952.0(2)	91.24(2)	SnC_4	C_{Ph} 204.8(4) 214.8(4,4) μC_2 206.3(4)	C,C 110.3(2,4)	130	
				FeC_6P_2	C_{cp} 208.1(5,14) μC_2 190.3(4) P_{dppm} 217.4(1)	cp,C 112.4.0(1) cp,P 134.0(1,0) C,P 84.7(1,1.9)		
[Ph$_2$Sn(μ-η^3-CO$_2$)Fe(CO)(cp)(PPh$_3$)] (orange)	m $P2_1/n$ 4	1771.5(5) 1315.6(4) 1774.9(5)	112.22(3)	SnC_3O_2	C_{Ph} 213.8(4,12) μOCO 206.9(2) 253.6(2)	C,C 106.5(1,1.1) 118.9(1) O,O 53.42(7)[g] C,O 99.2(1,15.8) 151.0(1) C,C 91.7(1) C,P 92.5(1,2.6)	131	
				FeC_7P	C_{in} 214.7(4.87) OC 174.2(3) μO_2C 199.3(3) P 222.3(1)			
[Ph$_2$Sn(μ-η^3-CO$_2$)Fe(CO)(cp)(PPh$_3$)] (yellow)	or Pbca 8	1797.2(2) 2025.4(4) 2014.8(3)		SnC_3O_2	C_{Ph} 214.1(6,18) μOCO 212.3(4) 234.2(4)	C,C 104.5(3,1.1) 116.0(2) O,O 57.4(1)[g] C,O 95.8(2,11.7) 126.3;148.7(2) C,P 92.5(2,1.6)	132	
				FeC_7P	C_{cp} not given OC 174.1(6) μO_2C 193.1(5) P 220.3(2)			
Me$_3$Sn(μ-η^3-CO$_2$)Fe(CO)(cp)(PPh$_3$)] (yellow)	m $P2_1/c$ 4	1057.4(3) 1332.9(8) 2334.6(9)	94.71(4)	SnC_3O_2	C_{Me} not given μOCO 208.9(3) 247.6(3)	O,O 55.94(9)[g] O,C 98.5(2,16.9) 149.9(2)	133	
				FeC_7P	μO_2C 193.6(4)	not given		
Bu$_3$Sn(μ-η^3-CO$_2$)Fe(CO)(cp)(PPh$_3$)] (yellow)	tr P1 2	1369.5(10) 1425.199) 1047.5(5)	90.99(5) 90.04(5) 85.05(5)	SnC_3O_2	C_{Bu} not given μOCO 210.5(4) 243.2(4)	O,O 56.5(1)[g] O,C 98.8(3,16.9) 149.8(3)	133	
				FeC_7P	μO_2C 193.4(6)	not given		
Ph$_3$Sn(μ-Fe(CO)$_2$(cp*))	m $P2_1/c$ 4	1231.8(3) 1190.7(4) 1939.9(4)	100.81(2)	SnC_3O_2	C_{Ph} not given μOCO 210.2(2) 239.4(2)	O,O 56.90(6)[g] O,C 99.2(1,21.4) 152.20(8)	133	
				FeC_8	μO_2C 195.6(3)	not given		

$Ph_3Sn(\mu\text{-}C_5H_4)Fe(cp)$	m	968.0(1)		SnC_4	C_{Ph} 214.3(3,3)	367.8	C C 109.4(1,3.0)	134
(yellow)	$P2_1/c$	1355.2(2)	100.36(1)		μC_L 212.3(3)			
	4	1779.4(3)		FeC_{10}	μC_L 204.2(5,14)		C C 40.4(2.6)[g]	
					C_{cp} 204.4(4,5)		68.1(2,5)	
							118.1(2,11.6)	
							159.0(2,1.4)	
$Cl_3Sn(\mu\text{-}C_5H_4S)$	m	1035.7(5)		$SnCl_3N_2$	Cl 234.7(4,25)		Cl,Cl 97.8(1.8.1)	135
$(NBu^t)_2\}$ Fe(cp)]	$P2_1/c$	1403.7(7)	92.79(3)		μN_L 213.4(3,40)		N,N 68.7(1)	
(orange)	4	1591.5(8)					Cl,N 100.9(1,11.0)	
							148.3(1,6.4)	
				FeC_{10}	not given		not given	
$[Cl_4Sn\{\mu\text{-}OP(Ph_2)$	m	1222.1(3)		$SnCl_4O_2$	Cl 238.0(1,9)		Cl,Cl 94.0(4,1.6)	136
$(C_5H_4)\}_2Fe]$	$P2_1/n$	2075.0(3)	105.94(2)		μO_L 211.9(10,8)		174.65(6)	
(yellow)	4	1390.2(2)					O O 85.3(8)	
							Cl,O 86.8(6,3.6)	
							172.3(6,3.9)	
				FeC_{10}	not given			
$[(2\text{-}Me_2NCH_2C_6H_4)_2Sn$	m	973.5(2)		SnN_2C_2Co	N 250.0(4,8)	243.8(1)	N N 150.7(1)	137
$Co(\eta^5\text{-}cp)(\eta^2\text{-}C_2H_4)]$	$P2_1/a$	1991.7(4)	90.36(1)		C 219.4(5,3)		C C 106.9(2)	
(red)	4	1242.9(1)					N C 72.6(1.0)[e]	
							89.9(2.5)	
							N Co 104.6(1,1)	
							C,Co 126.5(1,2.7)	
				CoC_7	$C_{\eta 2L}$ 206(1,3)		not given	
					C_{cp} not given			
$Cl_3SnCo(CO)_4$	or	1016.06(9)		$SnCl_3Co$	Cl 231.6(2,0)	247.7(1)	Cl,Cl 103.0(1)	138
	R3						Cl,Co 115.3(1)	
	3	929.4(2)		CoC_4	OC 179.0(6)		C C 94.3(2)	
					181.9(11)		C,Sn 85.7(2)	
$Ph_3SnCo(CO)_2$	m	1055.7(3)		SnC_3Co	C_{Ph} 217.0(3,16)	253.0(1)	not given	139
$\{C(OEt)Ncy_2\}(PMe_3)$	$P2_1$	1487.1(4)	111.70(2)	CoC_3P	OC 176.1(5,6)		C,C 119.6(2,2.3)	
(yellow)	2	1291.8(4)			C_L 198.9(4)		C,P 93.5(2,2.3)	
					P 218.1(2)		C Sn 86.6(2,4.7)	
							P,Sn 172.26(4)	
$Ph_2SnCo(\eta^4\text{-}C_{14}H_{10})$	m	1993.4(6)		SnC_3Co	C_{Ph} not given	254.6(2)	not given	140
$(PMe_3)_2$	$P2_1/c$	1053.0(4)	96.84(2)		C 206.0(14,2)		C,C 139.9(5,9)[g]	
(yellow)	4	1690.4(4)		CoC_4P_2	217.4(14,13)		P P 101.0(2)	
at 233K					P 219.3(5,3)		P,Sn 94.5(1,2.9)	

$Me_3SnCo(CO)_3$	tr	984.0(2)	99.606(2)	SnC_4Co	C_{Me} 212	256.5(1)	not given	141
$(AsPh_3)$	P1	1002.5(3)	107.814(1)					
(colourless)	2	1375.8(1)	94.8(2)	CoC_3As	OC 175.0(5,16)		C C 119.1(2.6)	
					As 228.9(1)		C,Sn 84.7(1,1.4)	
							As,Sn 177.6	
Ph(Me)	tr	1011.7(3)	111.94(4)	SnC_4Co	L,C 216.4(12)	257.2(1)	C C 110.1(5,2.7)	142
$\{CH_2CH(Me)(Ph)\}$	P1	1416.4(11)	91.64(3)		C_{Me} 214.4(10)		C Co 108.9(3,2.8)	
$SnCo(CO)_3(PPh_3)$	2	1339.6(5)	103.55(5)		C_{Ph} 213.5(11)			
				CoC_3P	OC 174.7(14,16)		C C 118.8(6,3.8)	
					P 220.3(13)		C,P 96.3(3,1.5)	
							C Sn 83.8(3,1.4)	
							P,Sn 177.2(1)	
$Me_3SnCo(CO)_3$	tr	984.9(3)	98.64(2)	SnC_4Co	C_{Me} 214	257.4(2)	not given	141
(PPh3)	P1	995.5(3)	107.43(3)	CoC_3P	OC 176.2,6)		C C 119.3(7,2.4)	
	2	1361.0(4)	95.620(3)		P 219.7(3)		C Sn 85.2(4,6)	
							P,Sn 177.9(1)	
$Ph_3SnCo(PMe_3)_3$	m	1796.9(5)		SnC_4Co	C_{Ph} 216.6(17,31)	259.0(2)	C C 99.1(6.9)	143
	$P2_1/c$	980.7(3)	102.10(2)				C,Co 118.5(4,3.1)	
	4	1856.9(5)		CoP_3	P 222.4(5,13)		P,P 103.0(2,7)	
							P,Sn 105.2(2,3.3)	
							133.6(2)	
$Ph_2SnCo(PMe_3)_3$	or	1918.2(3)		SnC_3Co	C_{Ph} 220.8(18.14)	259.1(2)	C,C 99.9(6,5)	143
	$Pna2_1$	3396.0(4)					C,Co 117.9(4,2.5)	
	8	985.1(1)		CoP_3	P 223.5(5,40)		P,P 105.7(2,1.1)	
							P,Sn 106.6(2,2.1)	
							125.8(1)	
				SnC_3Co	C_{Ph} 218.4(17,24)	259.8(2)	C,C 99.1(6.1.3)	
							C,Co 118.5(4,2.5)	
				CoP_3	P 222.3(6.40)		P,P 104.5(3,2.8)	
							P,Sn 102.4(2,1.2)	
							135.0(2)	
$Ph_3SnCo(CO)_3(PPh_3)$	m	2514(6)		SnC_3Co	not given			144
	C2/c	1546(8)	63.5(1)	CoC_3P	not given			
	8	1858(6)						

[Me(Ph)(CPh$_3$)	or	1842.9(17)		SnC$_3$Co	C$_{Me}$ 217.7(17)	259.4(2)	C C 105.3(6.9)	142
SnCo(CO)$_3$	P2$_1$2$_1$2$_1$	2380.3(16)			C$_{Ph}$ 218.1(15)		C Sn 109.9(4,1.6)	
{P(Ph$_2$)N(CH$_3$)(S)	4	1009.0(5)			C$_{Ph}$ 231.1(15)		120.1(4)	
CH(Me)Ph}]				CoC$_3$P	OC 217.9(17,2)		C C 119.5(9,8.8)	
					231.1(15)		C,P 93.7(5,3.2)	
					P 220.9(4)		C,Sn 86.3(5,3.0)	
							P Sn 173.6(1)	
Cl$_2$(Eu)Sn(μ-OMe)	m	2241.2(5)		SnO$_3$C$_2$C	C$_{Bu}$ 217.3(1)		not given	145
(μ-salen)CoCl	B2$_1$/a	1085.0(3)	70.31		μO$_{Me}$ 209.0(8)			
	8	2278.1(6)			μO$_{Sn}$ 235.5(6,55)			
					Cl 243.3(3,41)			
				CoO$_3$N$_2$Cl	μO$_{Me}$ 192.3(8)		not given	
					μO$_{Sn}$ 194.1(6,40)			
					N 189.9(9,38)			
					Cl 222.5(3)			
(NO$_3$)(bz)$_2$Sn	m	1801.6(3)		SnO$_5$C$_2$	μO 218.2(2,8)		O O 67.3(1,3)[e]	31
(μ-msp)Co(NO)$_3$	P2$_1$/n	1054.8(2)	107.413(10)		O 249.1(2,2)		75.1(1,4.9)	
	4	1809.9(2)			O$_2$NO 240.6(3)		141.2(1,4.3)	
					C$_{Ph}$ 214.4(4,5)		C C 168.95(14)	
				CoO$_3$N$_2$	μO 207.0(2,17)		O O 74.57(8)	
					N 205.8(3,19)		90.9(1.0)	
					O$_2$NO 207.4(4)		N,N 96.19(13)[d]	
[Me$_2$(H$_2$O)Sn(μ-msp)	m	963.3(2)		SnO$_5$C$_2$	μO 214.8(3,2)		O O 66.7(1,7)[e]	31
Co(NO)$_3$(H$_2$O)]NO$_3$	P2$_1$/c	1387.4(2)	99.84(1)		O 255.0(3,85)		76.1(1,3.5)	
	4	2048.2(3)			H$_2$O 255.7(4)		142.4(1,9.5)	
					C$_{Me}$ 209.5(5,0)		C,C 163.3(2)	
				CoO$_4$N$_2$	μO 203.9(3,11)		O O 77.20(12)	
					N 204.5(4,11)		89.5(2,1.9)	
					H$_2$O 218.0(4)		174.6(2)	
					O-NO 219.8(4)		N N 99.5(2)[d]	
{(Me$_3$Si)$_2$CH}$_2$Sn	m	1100.9(2)		SnC$_2$Ni	C 218.3(3,1)	238.7(1)	C,C 103.3(1)	146
Ni(η^2-CH=CH)$_2$	P2$_1$/c	1527.7(2)	107.76(1)				C,Ni 128.3(1,7.6)	
(yellow)	4	1719.1(1)		NiC$_4$	C 199.1(4,18)		not given	

$[Li(thf)_4]$	c	1829.8(2)		SnN_3Ni	N 208.6(6,0)	249.2(2)	N N 99.1(2)		10
$[\{HC[(SiMe_2N)(S)$	$P2_13$			NiC_3	OC 177(1,0)		C C 116.0(2)		
$CH(Me)Ph\}_3Sn$	4								
$Ni(CO)_3]$									
at 120K									
(BPh_4) $[Ph_3SnN(np_3)]^e$	m	1888(1)		SnC_3Ni	C_{Ph} 217.8(50,14)	254.1(10)	C C 99.2(2.4,5)		147
(cherry red)	$P2_1/c$	3853(2)	93.3(1)				C N 118.5(1.7,1.6)		
	8	1893(1)		NiP_3N	P 228.8(21,14)		P P 119.4(7,3.4)		
					N 216.9(49)		P N 85.6(1.4,1.0)		
							P,Sn 94.4(5,9)		
							N,Sn 179.3(1,3)		
				SnC_3Ni	C_{Ph} 209.7(37)	257.1(10)	C C 100.4(2.8,1.0)		
					218.7(59,7)		C Ni 117.4(1.7,1.8)		
				NiP_3N	P 227.8(20,33)		P P 119.7(7,2.9)		
					N 197.8(52)		P,N 86.9(1.6,2.9)		
							P,Sn 92.1(5,2.1)		
							N Sn 174.3(11,6)		
$[\{(Me_3Si)_2CH\}_2Sn$	m	1229.3(2)		SnC_1Ni	C 224.8(4,3)	262.6(1)	C C 100.9(1)		148
$(\mu\text{-}CH{=}CH)Ni$	$P2_1/n$	2257.5(3)	103.60(1)		μC_2 223.3(4)		C Ni 71.9(1)		
$(Pr^i_2PCH_2CH_2PPr^i_2)]$	4	1557.5(2)		NiP_2C	P 218.7(1,25)		P,P 88.5(1)[e]		
(red brown)					μC_2 193.3(4)		P,C 90.3(1)		
							175.2(1)		
							P,Sn 111.7(1)		
							159.3(1)		
							C,Sn 69.9(1)		
$[Me_2Cl_2Sn(\mu\text{-}Salen)$	m	924.4	115.6	$SnO_2C_2Cl_2$	μO_2 240.3(10)	341.2(2)	O,O 61.3(3)		149
Ni]	$P2_1/c$	1421.4			255.6(10)		C,C 161.0(7)		
	4	1705.8			C_{Me} 213(10,1)		Cl,Cl 97.1(2)		
					Cl 247.8(4.45)		O Cl 100.9(3,9.1)		
							161.9(3,9.2)		
							not given		
				NiO_2N_2	μO_2 186(2.1)				
					N 185(2.1)				
$[ErSn(\mu\text{-}msp)Ni(H_2O)$	m	1338.5(3)	97.008(2)	SnO_4Br	μO_2 219.4(4,5)		O,O 70.9(2)		150
$(CH_3CN)]Br$	$P2_1/c$	981.3(3)			264.6(5,4)		65.0(2.4)[e]		
(pale blue)	4	1931.9(4)			Br 271.0(1)		151.8(2)		
				NO_3N_3	not given		O,Br 85.5(1.8,2)		

$[Me_2Sn(\mu\text{-msp})$	m	1490.7(2)		SnO_4C_2	μO_L	206.9(3.0)	O,O	75.4(2)	151
$Ni(NCS)_2]$	C2/c	1158.8(2)	112.808(10)			255.4(3.0)		67.19(10)[e]	
(blue)	4	1628.6(2)			C_{Me}	209.4(4.0)		150.31(14)	
							C,C	135.3(3)	
							O,C	95.9(2,13.0)	
				NN_4O_2	μO_L	205.7(3.0)	N,N	95.0(2,7.2)	
					N	200.5(3)		173.9(2)	
					SCN	209.5(4.0)	O,O	75.9(2)	
							N,O	91.53(13)[d]	
								87.5(1.7)	
$[Bu_2Sn(\mu\text{-msp})$	m	1175.5(2)		SnO_4C_2	μO_L	209.1(3.4)	O,O	74.87(12)	151
$Ni(NCS)_2]$	$P2_1/c$	2046.2(5)	103.83(2)			258.5(3.18)		66.9(1.4)[e]	
(blue)	4	1425.6(4)			C_{Bu}	211.6(5.10)		151.73(11)	
							C,C	145.9(2)	
							O,C	94.7(2,1.0)	
				NN_4O_2	μO_L	205.9(3.1)	N,N	92.6(2.6.8)	
					N	201.2(4.5)		173.8(2)	
					SCN	217.8(5.11)	O,O	76.24(13)	
							N,O	92.1(2.1)[d]	
								87.6(2.2.8)	
$[Bu_2Sn(\mu\text{-msb})$	m	1219.4(2)		SnO_4C_2	μO_L	208.9(4.7)	O,O	75.1(2)	151
$Ni(NCS)_2]$	$P2_1/c$	2130.5(4)	104.34(2)			256.3(5.18)		67.8(2.6)[e]	
(blue)	4	1436.6(4)			C_{Bu}	212.0(7.4)		149.9(2)	
							C,C	145.5(3)	
							O,C	94.6(3.11.2)	
				NN_4O_2	μO_L	203.7(4.4)	N,N	94.4(3.9.3)	
					N	204.2(6.6)		173.3(3)	
					SCN	205.6(7.1)	O,O	75.2(2)	
							N,O	90.5(2.1)[d]	
								87.0(2.1.2)	

$[Me_2(dmf)Sn$	m	1339.97(12)		SnO_3C_2	μO_L	212.5(2.2)	O O	75.6(1,2.5)
$(\mu\text{-msp})\ Ni(NCS)_2]$	$P2_1/n$	1186.40(14)	103.805(8)			255.6(2,9)		66.6(1,1)[e]
(blue)	4	1991.7(2)			O_{dmf}	270.9(3)		153.63(7)
					C_{Me}	209.4(3,1)	C C	157.0(2)
							O C	90.3(1,12.4)
				NiN_2O_2	μO_L	204.4(2,4)	N N	92.3(1,5.0)
					N	202.5(3,5)		178.78(13)
					SCN	208.7(3,5)	O O	76.56(8)
							N,O	90.3(1,3.0)
$[Ph_2(NCS)Sn\ (\mu\text{-msp})$	tr	945.79(11)	96.080(13)	SnO_4C_2N	μO_L	217.6(2.4)	O O	70.63(8)
$Ni(NCS)_2]$	P1	1056.0(2)	96.998(11)			253.4(2.23)		65.7(1,4)[e]
(blue)	2	1951.4(3)	113.405(2)		C_{Ph}	212.6(36)		156.11(8)
					SCN	240.8(3)	C C	166.74(12)
							O C	91.9(1,7.8)
							O N	78.0(1,2)
							C N	83.6(1,9)
				NiN_4O_2	μO_L	204.6(2.0)	N N	93.8(1.8.9)
					N	203.4(2.12)		175.61(12)
					SCN	212.0(3.55)	O O	75.91(8)
							N O	91.8(1,5.1)
$[Me_2Sn(\mu\text{-msp})$	or	1005.2(2)		SnO_4C_2	μO_L	209.2(4.0)	O O	73.6(2)[e]
$N\ (NO_3)\ (H_2O)]\ NO_3$	$P2_12_12_1$	1340.4(2)				251.0(5,1)		58.0(2,1)
(blue)	4	1876.1(3)			C_{Me}	210.4(7,1)		141.6(2)
							C C	144.3(2,5.9)
							O C	95.2(3,11.1)
							O O	76.1(2)
				NiO_4N_2	μO_L	203.2(4,13)		91.8(2,7.4)
					N	200.8(6,7)		173.2(2)
					H_2O	208.8(5)	N N	101.7(2)[f]
					O_2NO	215.2(5)	O N	89.4(2,7.1)
								167.0(2,8)
$\{PPh_3(C_7H_7)\}_2$	m	2509.3(15)		$SnCl_4O_2$	μO_L	216.1(16,7)	O O	76.9(6)[e]
$[Cl_2Sn(\mu\text{-dtc})Ni$	$P2_1/c$	1582.3(9)	119.55(5)		Cl	233.7(7,9)	C,Cl	94.9(3,7.4)
$(dto)]\ H_2O$	4	1696.0(8)				237.9(8,1)		170.0(3)
(blue)							O,Cl	87.6(6,2.6)
				NiS_4	μS_L	216.5(8.6)	S,S	91.4(3,3)[e]
					S_L	214.6(9,10)		

$[Cl_3SnRu(\eta^6\text{-}C_6H_6)$ (Me) {Ph_2PNHCH (Me)Ph}] (amber)	or $P2_12_12_1$ 4	1008.0(5) 1191.6(4) 2430.1(7)		SnC_3Ru	Cl 236.6(4,0) 238.5(4)	254.3(1)	Cl,Cl 95.7(2,1.1) Cl,Ru 120.3(1,4.6) C,P 83.2(3) C,Sn 86.9(4) P,Sn 90.8(1)	153a
				RuC_7P	C_{Me} 215.5(9) C 226.4(24,14) P 229.5(3)			
$Cl_3SnRu(\eta^5\text{-}cp)$ {$Ph_2PCH(Me)$ CH_2PPh2} (yellow)	or $P2_12_12_1$ 4	943.6(2) 1726.3(4) 2169.2(4)		$SnCl_3Ru$	Cl 238.5	255.1(1)	not given	153b
				RuC_5P_2	C_{cp} 221 P 288.8		not given	
$[Cl_3SnRu(cp^*)$ (cod)] (orange)	m $P2_1/c$ 4	1293.0(1) 1009.1(1) 1579.3(2)	101.34(1)	$SnCl_3Ru$	Cl 239.1(2,5)	258.55(1)	Cl,Cl 95.1(1,5.0) Cl,Ru 121.6(1,6.3) Cp,Sn 115.6(1) π Sn 95.8(1,1.2)	154
				$RuC_5(\pi)_2$	cp^* 188.2(4) π_{cod} 214.7(4,11)			
$[Cl_3SnRu(CO)$ $Cl(PPh_3)_2$ $(Me_2CO)]$ Me_2CO (pale yellow)	m $P2_1/c$ 4	1195.0(3) 1498.8(3) 2491.6(2)	92.51(1)	$SnCl_3Ru$	Cl 237.4(2,15)	259.35(9)	Cl,Cl 93.69(3) Cl,Ru 98.6(2,2) 125.75(7)	155
				RuP_2OCCl	P 239.4(2,1) O_{Me} 219.4(8) CO 179.6(8) Cl 240.5(2)		P,P 169.52(8) P,O 91.6(2,5) P,C 89.4(2,9) P,Cl 85.0(1,6) P,Sn 95.2(1,3) O,Sn 75.3(2) C,Sn 92.3(2) Cl,Sn 166.23(8)	
$[Me_3SnRu(CO)$ (Cl) $(PPh_3)_2]$ (red)	m $P2_1/c$ 4	1185.9(1) 1881.7(6) 1700.4(13)	95.74(3)	SnC_3Ru	C_{Me} 216.5(6,19)	260.3(1)	C,C 104.2(-,2.3) C,Ru 114.3(-,2.5) P,P 162.5 P,Sn 98.7(-,1.4)	156
				RuP_2CCl	P 236.8(1,13) OC not given Cl not given			
$[Me_2(HS)SnRu(CO)$ $I(PPh_3)_2$ {CN(p-tolyl)}]	tr P1 2	1183.4(2) 1245.6(2) 1770.6(8)	104.57(2) 105.74(2) 66.66(1)	SnC_2SRu	C_{Me} 218.5(12) 223.4(8) HS 248.1(4)	264.5(1)	C,C 102.04(4) C,S 98.5(4,8.1) C,Ru 119.8(4,9) S,Ru 113.4(1)	157
				RuC_2P_2I	P 238.6(3,5) C not given I not given		not given	

$[Me_2Sn_2(\mu\text{-}\eta^4\text{-}CH_2C(CH_2)_2\}RuCl(C_5F_6)]$ (yellow)	or Pbc_21 8	1256.7(5) 1186.3(5) 2065.7(13)		SnC_4 RuC,Cl	C_{Me} 212.1,6) μC_L 217.5(8) μC_L 220.1(7.5) C 221.7(8.66) Cl 244.6(2)	not given	158
						C C 37.7(3,1)[g] 66.8(3)	
						C Cl 87.5(2,2.7) 111.7(3,8.5) 153.5(3,1.4)	
$Cl_3SnRh(tpp)$	tr P1 2	1271.9(2) 1290.6(2) 1693.0(3)	68.20(2) 68.23(2) 64.08(2)	$SnCl_3Rh$ RhN_4	Cl 231.1(7,10) N 201.7(9,17)	245.0(1)	159
						Cl,Rh 115.9(1,1.1)	
						N,N 90.0(3,4)[d]	
						N Sn 91.5(2,2.9)	
$[Ph_3SnRh(acac)$ {CH=CHClOH} $(CH_2)_4CH_2\}(PCy_3)]$ (red)	tr P1 2	1138.2(2) 1333.0(2) 1559.8(3)	93.70(1) 100.89(1) 101.96(1)	SnC_3Rh RhO_2C_2P	C_{Ph} not given O_{acac} 208.8(1,25) C_L 198.5(9) 211.2(20) P_{cy} 226.4(1)	254.60(6)	160
						not given	
						O O 88.1(1)[d]	
						O,C 92.0(4,3.6) 173.2(5,4)	
						O P 88.2; 167.6(1)	
						C,P 90.4(4.3.4)	
						O,Sn 94.0(1,10.7)	
						C,Sn 81.1(6,1)	
						P,Sn 109.10(4)	
$[Cl\{(Me_3Si)_2N\}_2Sn$ $Rh(\eta\text{-tol})(\eta\text{-}C_8H_{14})]$	tr P1 2	1101.3(2) 1170.9(3) 1646.9(3)	102.77(2) 94.39(2) 116.15(2)	SnN_2ClRh RhC_x	N 208.6(9) Cl 243.7(2) L_1 183.3 L_2 202.1	255.4(1)	161
						N Rh 110.1(1,5.2)	
						Cl,Rh 104.31(4)	
						L_1,L_2 141	
						L_1,Sn 128	
						L_2,Sn 90	
$[C_3SnIrh(ntd)(gcn)]$ (deep blue)	m $P2_1/n$ 4	938.3(3) 956.9(2) 2696.7(5)	93.24(2)	$SnCl_3Rh$ RhC_4N_2	Cl 240.5(1) C 216(1,2) N 206(1,4)	261.0(1)	162
						Cl,Cl 97.7(2,1.3)	
						Cl,Rh 119.6(1.2.5)	
						N N 77.1(4)[e]	
						N Sn 92.7(3.6)	
						C,Sn 37.1(4,8) 124.3(4,2)	

[Cl$_3$Sn(Rh(nbd)(dppp)] (yellow)	m $P2_1/n$ 4	2018.9(4) 1837.3(3) 9268.3(3)	90.69(2)	$SnCl_3Rh$ RhC_4P_2	Cl 241.9(3,10) C 222.3(9,34) P 229.6(2,1)	263.7(1)	Cl,Cl 95.4(1,2.4) Cl,Rh 121.2(1,4.5) P,P 91.1(1) P,Sn 97.9(1,1.3) C,Sn 82.7(3,1.4) 118.4(3,1.7)	163
[Ph$_3$Sn(μ-C≡CCH$_2$OMe)Rh(Cl)(PPr$^i_3$)$_2$]	m $P2_1/n$ 4	1202.6(3) 1989.5(3) 1838.1(5)	102.30(1)	SnC_4 RhP_2CCl	C_{Ph} 214.0(5,12) μC_L 214.3(5) μC_L 181.6(4) P 235.6(1,3) Cl 238.4(1)		C,C 110.0(2,4.5) P,P 170.31(4) P,C 90.2(1,1) P,Cl 90.0(1.5) C,Cl 176.3(1)	164
(PPh$_4$)[Cl$_3$SnPdCl$_3$]	tr_ P$\bar{1}$ 2	1071.0(3) 1170.1(3) 2225.2(5)	76.12(2) 93.37(2) 117.74(1)	$SnCl_3Pd$ $PdCl_3$	Cl 236.6(7,4) Cl 229.0(6) 237.7(6,6)	247.3(6)	Cl,Cl 97.0(3,2.4) Cl,Pd 113.8(2) 123.2(2,1.5) Cl,Cl 93.9(2,1.9) 171.9(9) Cl,Sn 86.0(2,7) 175.4(1)	165
{(Me$_3$Si)$_2$CH}$_2$Sn Pd{Pr$^i_2$P(CH$_2$)$_2$PPr$^i_2$} (red)	m $P2_1/n$ 4	1000.7(2) 3203.6(5) 1320.3(1)	91.98(1)	SnC_2Pd PdP_2	C 221(2,0) P 228.9(4.4)	248.1(2)	C,C 98.8(5) C,Pd 130.5(4.7) P,P 89.0(2) P,Sn 135.4(1,1.6)	166
[Cl$_3$SnPd{η^3-CH$_2$C(Me)CH$_2$}(styrene)]	tr_ P$\bar{1}$ 2	874.0(2) 933.8(2) 1093.1(2)	72.43(1) 89.38(1) 73.33(2)	$SnCl_3Pd$ PdC_5	Cl 238.3(1,4) C 217.2(4,30) 227.4(4,26)	255.42(6)	C,Cl 96.5(1,1) C,Pd 120.5(1,3.0) L_1,L_2 134.5(2) L_1,Sn 121.9(3) L_2,Sn 103.5(1)	167
[Cl$_3$SnPd(CO)(η^3-C$_4$H$_7$)]	tr_ P$\bar{1}$ 2	897.1(2) 903.2(2) 716.8(1)	99.77(2) 105.09(2) 86.34(2)	$SnCl_3Pd$ PdC_4	Cl 237.2(3,1) 239.5(2) OC 194.7(11) C_nL 217.2(13,40)	256.07(12)	Cl,Cl 98.4(1,3.4) Cl,Pd 118.0(1,4) 124.33(8) C,Sn 95.8(5,6.0) 123.7(2) 156.4(3)	168

$[Cl_3Sn]^2d$ (η^3-allyl)	m	1280(2)		$SnCl_3Fd$	Cl 237.3(4.3)	255.3(1)	Cl,Cl	95.5(1,2.8)	169
$(PPh_3)_2$]	$P2_1/c$	2203(4)	103.2)(5)		239.9(3)		C,Pd	121.3(1,1.6)	
	4	944(2)		PdC_3P	C 217.3(2.57)		C,Sn	89.37(32)	
					P 231.7(3)			157.74(41)	
							P,Sn	98.80(7)	
$(Me_3Si)CH_2Sn$	m	1242.4(1)		SnC_3Fd	L,C 223.6(3.4)	257.0(1)	C,C	103.0(1)	166
$(\mu$-CH=CH)Pd	$P2_1/n$	2264.7(2)	104.05(1)		μC_L 215.0(3)		C,Pd	74.0(1)	
$\{Pr^i_2P(CH_2)_2PPr^i_2\}$	4	1560.1(1)		PdP_2C	P 231.3(1.28)		P,P	86.2(.)°	
(yellow-orange)					μC_2 205.1(3)		P,C	91.2(1)	
								174.8(1)	
							P,Sn	115.0(1)	
								158.5(1)	
$Me_2Sn\{\mu$-$(CH_2)_2PPh_2\}$		not given		SnC_4	not given	257.3(2)			170
$Pd(\mu$-$P(Ph)_2)(CH_2)_2$				PdC_2P_2	not given				
$S(Me_2)C(CO_2Me)$									
$C(CO_2Me)\}$									
(pale yellow)									
$C_3SnIr(nbd)$	m	961.6(1)	96.72(1)	$SnCl_3Ir$	Cl 240.0(3.9)	258.67(6)	C,Cl	95.5(1,2.1)	171
$(PMe_2Ph)_2$	$P2_1/c$	2852.0(6)			241.7(2)		C,Ir	121.3(1,2.9)	
(yellow)	4	976.4(1)		IrC_4P_2	C 220.9(6.36)		P,P	96.19(5)	
					P 230.7(1,2)		P,Sn	96.4(1.6)	
$Ph_3SnIr(H)_3(cp^*)$	tr_-	9743.8(9)	101.382(6)	SnC_3Ir	C_{Ph} 216.2(3.8)	258.8(1)	C,C	104.5(1,9)	172
(colourless)	$P\bar{1}$	1118.93(10)	98.282(9)				C,Ir	114.1(1,5)	
	2	1113.64(10)	94.786(8)	IrC_5H_2	H 153(3.8)		H,H	70.8(16,1.1)	
					C_{cp} 224.1(3.37)		H,Sn	67.3(11,1.6)	
								102.5(12)	
							cp,Sn	128.94	
$Ph_3SnIr(H)_2(tfb)$	tr_-	1092.3(1)	75.076(5)	SnC_3Ir	C_{Ph} not given	251.22(5)		not given	173
(PCy_3)	$P\bar{1}$	1094.3(1)	77.504(5)	IrC_4H_2F	C 224.9(6,19)		H,H	96(3)	
(pale yellow)	2	1967.9(1)	72.606(5)		H 151(5,4)		H,P	77(2)	
					P 236.3(1)		H,Sn	66(2,2)	
							P,Sn	129.46(3)	

$Cl_3SnIr(H)_2(PPh_3)_3$	m	1387.4(3)		$SnCl_3Ir$	Cl 239.1(5,9)	262.3(1)	Cl,Cl 95.8(1,9)	174
(colourless)	$P2_1/n$	2357.1(5)	96.10(2)				Cl,Ir 120.1(1,4.4)	
	4	1526.1(3)		IrP_3H_2	H 169(9,1)		H,P 75(4,1); 173(4)	
					P 235.1(4.44)		P,P 103.7(1,1.5)	
							H,Sn 86(5); 168(2)	
							P,Sn 98.3(1,..7)	
$[Me_2BrSn(\mu\text{-}Br)$	tr	1012.2(2)	66.83(1)	SnC_2B_2Ir	C_{Me} 215.1(9,15)	262.97(8)	C,C 110.7(3)	175
Ir(cod)	$P\bar{1}$	1413.6(2)	69.35(1)		Br 260.8(1)	56.52(3)	B,Br 169.47(4)	
$\{2\text{-}(Me_2N)CH_2)$	4	1731.0(2)	73.64(2)		μBr 293.4(1)		C,Ir 117.4(3)	
$C_6H_4\}]^a$							B,Ir 54.97(3)	
							116.35(4)	
				IrC_3NBr	C 212.6(8,54)		C,Sn 81.3(2)	
					N 235.7(7)		N,Sn 142.0(2)	
					μBr 258.2(1)		B,Sn 68.51(3)	
				SnC_2Br_2Ir	C_{Me} 214.6(9,6)	263.58(8)	C,C 114.2(3)	
					Br 252.6(1)	56.57(3)	B,Br 170.87(4)	
					μBr 293.4(1)		C,Ir 116.6(3,1)	
							B,Ir 55.17(3)	
							116.59(4)	
				IrC_3NBr	C 212.7(8,58)		C,Sn 81.2(2)	
					N 234.2(7)		N,Sn 141.8(2)	
					μBr 259.2(1)		B,Sn 68.26(3)	
$Cl_2SnIr(cod)_2$	m	1685(2)		$SnCl_3Ir$	Cl 239.5(12,11)	264.2(2)	Cl,Cl 96.0(4,8)	176
	$P2_1/c$	955(2)	112.6(5)				Cl,Ir 113.5(2)	
	4	1201(2)					124.3(3,1.0)	
				IrC_8	C 220.7(36,65)		C,Sn 83.5(9,11.7)	
							117.7(8,12.5)	
$Ph_3SnIr(CO)_3(Pcy_3)$	m	1464.3(2)		SnC_2Ir	C_{Pc} not given	266.10(3)	not given	177
(colourless)	$P2_1/n$	1304.8(1)	95.26(1)	IrC,P	OC 190.5(3.5)		C,C 119.5(2.7)	
	4	1951.0(4)			P 237.45(8)		C,P 94.1(1,2.1)	
							C,Sn 85.0(1,1.4)	
							P,Sn 176.04(3)	

[ClSn(crown-P_2)	or	971.9(2)	SnO_4N_2Cl	O 272.8(1,136)	292.0(2)	O,O 60.9(9,1.8)	178
$Ir(CO)Cl_2SnCl_3$	Pc2$_1$b	2239.1(5)		N 288.6(1,93)		O,Cl 79.1(7,1.1)	
$2CHCl_3$	4	2278.2(7)		Cl 252.8(7)		N,N 161.9(10)	
(yellow-orange)						N,Cl 98.7(8,1.4)	
at 130K						O,N 61.9(9,2.4)	
			IrP_2CCl	P 232.7(7,36)		P,P 161.8(2)	
				OC 185(2)		P,C 94.4(7,1.8)	
				C 238.4(6)		P,Cl 85.6(2.4)	
						C,Cl 177.8(7)	
$[Me_2Cl_2Sn\{\mu\text{-}P(O)$	or	3185.7(4)	SnC_2Cl_2O	μO 230(2)		not given	179
$(OMe)\}]$	Pnn2	1323.0(2)		C_{Me} not given			
$Ir(H)\{P(OMe)_3\}_4]$	4	1056.0(2)		Cl not given			
$[SnCl_3Me_2]$			IrP_3H	P 231.6(11,66)		not given	
				$\mu P_{1,}$ 232.2(10)			
$(PhCH_2PPh_3)_2$	tr	1104.6(7)	$SnBr_3Pt$	Br 250.2(4)	248.6(3)	Br,Br 98.3(1,1.3)	180
$[Br_3SnPtBr_3]$	P$\bar{1}$	1416.4(9)		252.9(4,3)		Br,Pt 119.1(1,4.4)	
	2	2254.9(10)	$PtBr_3$	Br 242.2(3,9)		Br,Br 91.0(1,9)	
				247.8(2)		Br,Sn 88.9(1,7)	
$[Cl_3SnPtC(PEt_3)$	m	1594.5	$SnCl_3Pt$	Cl 234.0(3,10)	250.1(1)	not given	181
(ba:e)]	$P2_1/c$	1010.6	106.67				
(yellow)	4	1808.9	PtNClP	N_{iso} 209.7(7)		N Cl 87.0(2)	
				Cl 232.5(3)		N P 175.4(2)	
				P_{Et} 234.2(3)		N Sn 89.1(2)	
						Cl,Sn 175.8(1)	
						P,Sn 95.6(1)	
$[Cl_3SnPtCl(PEt_3)$	m	1063.1(6)	$SnCl_3Pt$	Cl not given	251.4(1)	not given	182
(4-cha)]	$P2_1/n$	921.4(4)	90.77(3)	N_{cha} 215.2(11)		N Cl 85.0(3)	
(yellow)	4	2157.6(4)	PtNClP	Cl 233.1(3)		N,P 173.0(4)	
				P_{Et} 223.3(4)		Cl,P 88.0(1)	
						N Sn 92.0(5)	
						Cl Sn 174.3(1)	
						P,Sn 95.0(1)	

$[Ph_2(Cl)SnPt(Cl)$	m	1385.8(8)		SnC_2ClPt	C_{Ph} 211(1,1)	253.4(1)	C C 110.2(4)	183
(C_2H_4) (dmphen)]	$P2_1/n$	1373.0(6)	102.44(5)		Cl 239.3(3)		C Cl 102.1(3,2)	
(pale yellow)	4	1682.0(8)					C,Pt 116.2(3,2)	
							Cl,Pt 108.0(1)	
				PtN_2C_2Cl	N 220(1,1)		N N 76.3(3)[e]	
					C 208(1,1)		C C 39.6(5)[g]	
					Cl 247.8(3)		N Sn 89.1(2,8)	
							C Sn 89.5(4,2.1)	
							Cl,Sn 173.31(9)	
$[Cl_3SnPt(\eta^2$-styrene)	tr_	869.7(2)	72.32(2)	$SnCl_3Pt$	Cl 236.8(1,3)	253.93(7)	Cl,Cl 97.4(1,1.0)	167
$(\eta^3$-$C_4H_7)]$	P1	937.3(2)	89.76(2)				C,Pt 119.8(1,3.3)	
(yellow)	2	1101.5(2)	73.30(2)	PtC_5	C_{t2L} 220.8(7,28)		C,Sn 86.9(2,8)	
					C_{t3L} 217.2(8,21)		120.8(2.6)	
							153.47(21)	
$[Me_2ClSnPtMe_2$	m	1103.2(2)		SnC_2ClPt	C_{Me} 210.1(21,4)	254.1(2)	C C 119.4(11)	184
$(Bu^t_2bpy)]$ BF_4	$P2_1$	1173.3(1)	113.57(1)		Cl 244.4(5)		C Cl 101.9(8,9)	
	2	1168.1(2)					C,Pt 115.0(7,3.9)	
							Cl,Pt 98.6(1)	
				PtN_2C_2	C_{Me} 208.4(17,8)		C C 88.1(8)	
					N 213.2(12,18)		N N 77.5(5)[e]	
							C Sn 87.6(6,1.3)	
							N Sn 96.5(4,3.2)	
$[Me_3SnPtMe_2$	m	1120.4(2)		SnC_3Pt	C_{Me} 218.4(47,16)	254.7(5)	C C 107.9(18,2)	185
$I(Bu^t_2bpy)]$ (Me_3SnI)	$P2_1/m$	1392.6(2)	96.40(1)				C,Pt 110.9(17,5.9)	
CH_2Cl_2[c]	2	2248.5(3)		PtN_2C_2F	C_{Me} 206.3(26,0)		C C 88.1(14)	
					N 214.0(18,0)		N,N 77.0(10)[e]	
					I 288.1(4)		C Sn 88.1(8.0)	
							N Sn 92.2(5.0)	
				$SnCl_3Pt$	C_{Me} 220.8(50,81)	256.7(4)	C C 110.5(17,14)	
							C,Pt 108.5(8.7)	
				PtN_2C_2F	C_{Me} 204.8(24.0)		C C 93.6(14)	
					N 211.5(21.0)		N N 74.7(11)[e]	
					I 295.9(4)		C Sn 86.2(8.0)	
							N Sn 96.4(15,0)	

$[Cl_3MeSnPt(Cl)_2(dman)_2]\cdot CH_2C_{12}$ (yellow)	or $P2_12_12_1$ 4	1107.16(4) 1163.05(9) 2264.63(9)		$SnCl_2CPt$	Cl 237.5(3,1) C_{Me} 211.4(9)	254.89(5)	Cl Cl 99.36(9) Cl C 100.8(3,3.2) C,Pt 113.6(1,3.5) C,Pt 125.0(3) C,N 80.8(3,1.6)[e] C,Sn 81.2(2,3.7) N,Sn 98.2(0(18) 155.9(0(16) C,Sn 99.61(5)	186
				PtC_2N_2Cl	C 200.9(7,1) N 223.3(7) 234.8(6) Cl 241.0(2)			
$[Cl_3SnPt(CO)(\eta^2\text{-}C_4H_7)]$ (colourless)	tr $P\bar{1}$ 2	891.2(2) 907.6(2) 726.3(1)	98.92(1) 105.80(1) 86.06(1)	$SnCl_3Pt$ PtC_4	Cl 235.8(2.0) 237.9(2) OC 18/8(7) $C_{\eta L}$ 218.1(7,28)	254.96(7)	Cl Cl 98.0(1,2.6) C,Pt 119.2(1,5.1) C,Sn 95.3(2,4.8) 123.8(2) 157.0(2)	168
$Ph_3SnPt(H)(PPh_3)_2$ (pale yellow)	tr $P\bar{1}$ 2	1283.2(3) 1424.6(3) 1442.2(3)	73.46(4) 71.83(4) 66.71(3)	SnC_3Pt $PtHP_2$	C_{Ph} 213.1(4.6) H not given P 229.7(1,8)	256.4(1)	C C 102.1(2,4.5) C,Pt 116.2(1,7.5) P,P 110.20(4) P,Sn 93.27(3) 155.75(3)	187
$Cl_3SnPtCl(PPh_3)_2$ (pale yellow)	m $P2_1/n$ 4	1289.5(3) 1684.4(3) 1662.0(3)	102.38(1)	$SnCl_3Pt$ PtP_2Cl	Cl 234.1(3) 235.7(3.2) P 228.6(2.31) Cl 233.3(2)	259.0(1)	Cl,Cl 97.9(1.2.8) Cl,Pt 119.3(1,7.9) P,Sn 93.0(1) 168.3(1) C,Sn 78.0(1)	188
$Cl_3SnPt(H)(Pcy_3)_2$ (white)	tr $P\bar{1}$ 2	948.5(1) 1198.3(2) 2192.1(3)	108.52(1) 104.92(1) 93.66(1)	$SnCl_3Pt$ PtP_2H	Cl 237.5(8) 239.3(9.1) H not given P 231.0(5,5)	260.0(2)	Cl,Cl 96.3(3.1.8) C,Pt 120.6(2,4.8) P,P 159.0(2) P,Sn 100.0(2,1.8)	189
$Cl_3SnPt(H)(PPh_3)_2$	m $C2/c$ 8	3134.5(5) 1271.6(3) 1813.5(3)	96.5(2)	$SnCl_3Pt$ PtP_2H	Cl 228.3(5) 237.0(6,3) H not given P 230.1(4.2)	260.1(1)	C,Cl 96.8(2,3.8) C,Pt 120.4(1,4.9) P,P 161.3(1) P,Sn 98.8(1,4)	190

$[Cl_3SnPt(I)(bdpp)]$	m	1548.8(2)		$SnCl_3Pt$	Cl not given	261.13(13)	not given	191
$CHCl_3$[c]	$P2_1$	1499.9(2)	98.67(1)	PtP_2I	P 227.5(5,28)		P,Sn 90.64(12)	
(yellow)	4	1630.3(2)			I 255.65(13)		173.66(13)	
							I,Sn 82.96(4)	
				$SnCl_3Pt$	Cl not given		not given	
				PtP_2I	P 227.5(4,2.2)	261.54(14)	P,Sn 91.95(12)	
					I 254.15(13)		174.84(14)	
							I,Sn 86.73(4)	
$Cl_3SnPt(PhCO)$	or	1026.6(3)		$SnCl_3Pt$	Cl 238.3(7,14)	263.4(1)	Cl,Cl 96.5(2,1.6)	192
$(Et_3)_2$	$P2_12_12_1$	1547.6(2)					Cl,Pt 120.4(1,8.1)	
(yellow)	4	1774.0(2)		PtP_2C	P 238.3(7,15)		P,Sn 91.9(1,2)	
					C 205(1)		C,Sn 173.0(3)	
$Ph_3SnPt(H)(Pcy_3)_2$	m	1046.8(3)		SnC_3Pt	C_{Pt} 218.3(9,3)	265.39(6)	C,C 98.3(3,3.3)	189
(yellow)	$P2_1$	1862.7(6)	105.62(2)				C,Pt 119.1(2,3.8)	
	2	1355.3(3)		PtP_2H	H not given		P,P 160.24(8)	
					P 228.8(2,6)		P,Sn 99.6(1,3.8)	
$[Ph_2Sn\{\mu\text{-}\eta^3\text{-}$	t_	1190.76(33)	95.22(2)	SnC_4	C_{Ph} 215(2,1)		μC,C 111.1(7,6.0)	193
$C(S)SMe\}Pt(PPh_3)_2]$	P1	1245.11(37)	100.49(2)		μC 217(2)			
(yellow)	2	1846.47(36)	114.92(2)	PtP_2SC	P 229.5(5,34)	-	P,P 100.3(2)	
					μS_L 230.2(5)	122.2(8)	P,S 103.0(2)	
					μC 212.2(17)		P,C 108.2(5)	
							S,C 48.5(5)[g]	
$Ph_2SnU(cp)_3$	or	1910.0(5)		SnC_3U	C_{Ph} 221	316.6(1)	not given	194
(brown)	Pbca	1819.5(4)						
	8	1608.4(5)		UC_{15}	C_{cp} 268 - 279		not given	

Footnotes: a. Where more than one chemically equivalent distance or angle is present, the mean value is tabulated. The first number in parenthesis is the e.s.d., and the second is the maximum deviation from the mean.

b. The chemical identity of the coordinated atom or ligand is specified in these columns.

c. Two crystallographically independent molecules.

d. Six member metallocyclic ring.

e. Five member metallocyclic ring.

f. Four member metallocyclic ring.

g. Three member metallocyclic ring.

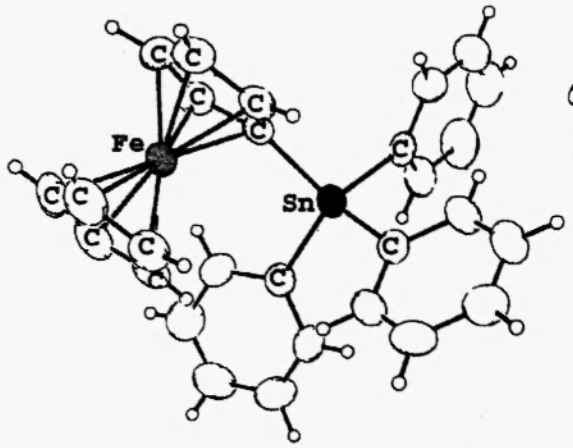

Fig. 5. Structure of $Ph_3Sn(\mu\text{-}C_5H_4)Fecp$ [134]

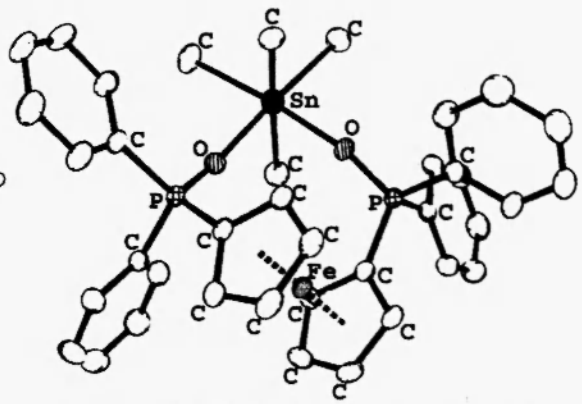

Fig. 6. Structure of $[Cl_4Sn\{\mu\text{-}OP(Ph_2)(C_5H_4)\}_2Fe]$ {136]

Thirteen derivatives contain tin and nickel atoms [10,31,146-152], four of them having a direct Sn-Ni bond [10,146-148] of average value 252.3 pm (range 238.7(10 to 262.6(1) pm). In one of these [146] the tin atom has trigonal-planar geometry (SnC_2Ni) and nickel has a five-coordinate arrangement (NiC_4Sn). In the remaining derivatives [10,147,148] the tin atoms are pseudo-tetrahedral (SnN_3Ni [10], SnC_3Ni [147,148]). Two crystallographically independent hetero-dimers are found in one of these [147], differing mostly by degree of distortion. The Sn-Ni bond distances are 254.1(10) pm in one distortion isomer and 257.1(10) pm in the other. In $Me_2Cl_2Sn(\mu\text{-salen})Ni$ [149] the salen ligand uses its two O atoms to link both metal atoms while two N atoms are bonded only to nickel. The nickel atom is approximately square planar (NiO_2N_2) and the tin is pseudo-octahedral ($SnO_2C_2Cl_2$). The Sn-Ni separation of 341.2(2) pm precludes a direct metal-metal bond. Seven blue coloured derivatives have Schiff bases serving as bridging ligands [31,150,151]. Each base uses four O atoms to bind tin, of which two also bind to nickel to give a four-membered metallocycle (-Sn-O-Ni-O-). The two N donor atoms of the base are bonded to nickel. The tin atom can be found five-coordinated (SnO_4Br) [150], six-coordinated in four derivatives (SnO_4C_2) [31,151] and seven-coordinate pentagonal-bipyramidal in two others [151]. Another blue derivative [152] uses dithioxalate to link Cl_4Sn and Ni(dto) moieties. The dithioxalate group uses two O atoms to bind tin (pseudo-octahedral $SnCl_4O_2$) and two S atoms to bind nickel (planar NiS_4).

Seven, mostly yellow, derivatives contain tin and ruthenium [153-158], six of which contain a direct Sn-Ru bond [153-157]. The average intermetal bond length is 258.7 pm with a range from 254.3(1) to 264.5(1) pm. In each case the tin has a pseudo-tetrahedral environment, $SnCl_3Ru$ [153-155], SnC_3Ru [156] and SnC_2SRu [157]. The remaining derivative [158] has Me_3Sn and $Ru(C_6H_6)Cl$ moieties joined by a $\mu\text{-}\eta^3$-methallyl group through one C atom to Sn and by another two C atoms to Ru.

Six derivatives combine tin and rhodium [159-164] of which five have a direct Sn-Rh bond [159-163] of average length 256 pm (range 245.0(1) to 263.7(1) pm). The tin atom has a tetrahedral arrangement, $SnCl_3Rh$ [159,162,163], SnC_3Rh [160] and SnN_2ClRh [161]. The rhodium atom has varied arrangements, RhN_4Sn [159]. RhO_2C_2PSn [160], $Rh(c\text{-}ring)_2Sn$ [161], RhC_4N_2Sn [162] and RhC_4P_2Sn [163]. The structure of a derivative in which both metals are four-coordinate is shown in Figure 7 [164] The tin atom has the usual tetrahedral symmetry (SnC_4) while the rhodium atom has a square planar arrangement (RhP_2CCl).

There a seven derivatives with tin and palladium atoms [165-170] all of which contain a direct Sn-Pd bond of average length 254.3 pm, ranging from 247.3(6) to 267.0(1) pm. The tin atoms are trigonal-planar (SnC_2Pd) [166] and tetrahedral [165-170]. The rhodium atoms are three-coordinate [166], four [165,166], five [168,170] and six-coordinate [167].

Nine derivatives have tin and iridium atoms [171-179] of which seven have a direct Sn-Ir bond with an average distance of 262.2 pm (range 258.67(6) to 266.10(3) pm). Tin atoms are mostly tetrahedrally coordinated, $SnCl_3Ir$ [171,176,177] and SnC_3Ir [172,173,177], with one example which is trigonal-bipyramidal (SnC_2Br_2Ir) [175], the Br atoms occupying apical positions (Br-Sn-Br angle of 169.47(4) °. In this latter derivative a pair of distortion isomers are found in the same crystal. A yellow-orange derivative [178] has the tin atom asymmetrically placed within the diaza-crown part of the crown-P_2 ligand (SnO_4N_2), becoming seven-coordinate with the addition of a chlorine atom. The diaza-crown-P_2 group bonds to the iridium via both P atoms, and a planar coordination is completed by a CO group and a Cl atom. The Sn-Ir distance is 292.0(2) pm.

In the remaining derivative [179] the Me_2Cl_2Sn and $Ir(H)\{P(OMe)_3\}_4$ moieties are held together by μ-P(O)(OMe) via an O atom to tin and a P atom to iridium.

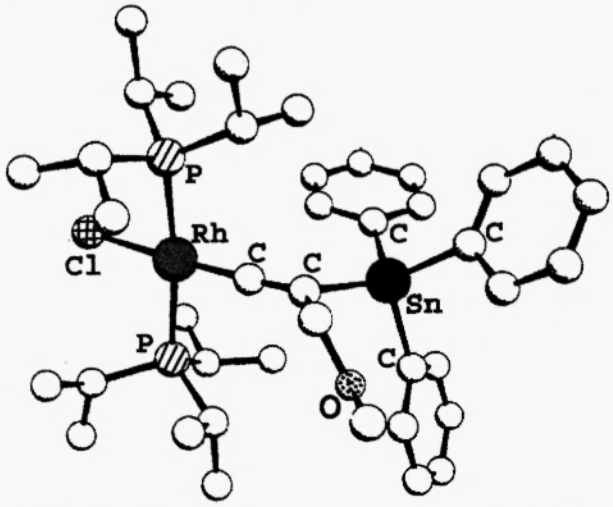

Figure 7. Structure of $Ph_3Sn(\mu\text{-}CC{=}CCH_2Ome)Rh(Cl)(P^iPr_3)_2$ [164]

Seventeen derivatives [167,168,180-193] contain tin and platinum. Sixteen of these have a direct Sn-Pt bond [167,168,180-192] with an average length of 256.6 pm and range from 248.6(3) to 265.39(6) pm. The tin atoms are in tetrahedral environments, $SnBr_3Pt$ [180], $SnCl_3Pt$ [167,168,181,182,188-192], SnC_2ClPt [183,184] and $SnCl_2CPt$ [184,186]. The platinum atoms are four-coordinate [180-182,187-192], five [168,184] and six-coordinate [167,183,185,186]. Two derivatives contain a pair of crystallographically independent hetero-dimers, differing mostly by degree of distortion. The structure of a yellow derivative is shown in Figure 8 [193]. The molecular geometry clearly indicates that the $Ph_3SnC(S)SMe$ moiety is bound to Pt(0) in a η^2-mode. The coordination about platinum is approximately planar (PtP_2CS) and tetrahedral about tin (SnC_4).

For the Actinide series there is only one example [194], and this combines tin with uranium. It is a brown complex the structure of which is shown in Figure 9. It consists of two interpenetrating pseudo-tetrahedral units Ph_3SnU and cp_3Usn, with a Sn-U bond distance of 316.6(1) pm which reflects the size of the uranium atom.

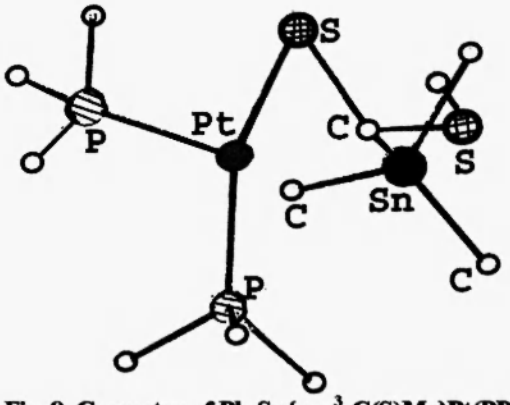

Fig. 8. Geometry of $Ph_3Sn\{\mu\text{-}\eta^3\text{-}C(S)Me\}Pt(PPh_3)_2$ [193]

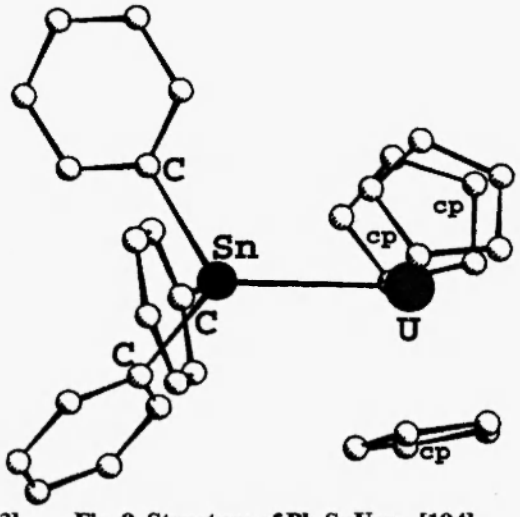

Fig. 9. Structure of Ph_3SnUcp_2 [194]

3. CONCLUSIONS

This review summarises the data for over two hundred and forty dimeric heterometallic compounds of tin. The heterometal atoms include non-transition (or Group A) metals; Li(x8), Na(x1), K(x3), Al(x1), Tl(x1), Ge(x7) and Pb(x1); and transition (or Group B) metals, Cu(x2), Ag(x2), Au(x1), Zn(x2), Ti(x4), Zr(x2), V(x5),

Nb(x4), Ta(x1), Cr(x19), Mo(x25), W(x19), Mn(x13), Tc(x1), Re(x6), Fe(x31), Co(x14). Ni(x13), Ru(x7), Rh(x6), Pd(x7), Ir (x9) and Pt(x17). In addition there is one example for the actinides, uranium .

For the tin atom the geometries involved are tetrahedral, trigonal-bipyramidal, pseudo-octahedral and pentagonal-bipyramidal, of which the first two are most common, with the most important being tetrahedral. The most common ligands for tin are a chlorine atom and phenyl group. The mean Sn-L bond distance for tetrahedral tin increases in the order of increasing donor atom covalent radius: 215 pm (LN, 75 pm) < 216 pm (LC, 77 pm) < 238 pm (Cl, 99 pm) < 248 pm (LS, 102 pm) < 252 pm (Br, 114 pm) < 263 pm (LSi, 117 pm). The mean Sn-C bond distance decreases with increasing coordination number about tin in the order: 218 pm (three) > 216 pm (four, five) > 212 pm (six and seven).

One example $[Sn(\mu\text{-}COSiPh_3)_3K(dme)_2]$ [15] exists in two isomeric forms, monoclinic and triclinic. The triclinic form itself contains two crystallographically independent hetero-dimers. There are several other examples of this type of isomerism [8,9,15,19,24,32,67,94,96,126,143,147,175,185,191]. One example even contains four crystallographically independent hetero-dimers within the same crystal. In all of these the molecules differ mostly by degree of distortion (Sn-L and L-Sn-L parameters) are examples of distortion isomersm [195].

Only about ten percent of the examples have tin with a non-transition metal, and of these lithium with 8 examples and germanium with seven are the most common. The Sn-M distance for this group are given in Table 3. There is a tendency for the Sn-M bond distance to increase with the covalent radius of the heterometal atom. The shortest metal-metal bond of 253.7(6) pm is found for germanium [19].

The other ninety percent of the derivatives contain a transition metal. These are wide ranging, but the chromium subgroup and the iron subgroup predominate with over sixty examples each. The former includes Cr(x19), Mo(x25) and W(x19), and the latter includes Fe(x31), Co(x14), Ni(x13) and Pt(17). In this class of derivatives the majority have a Sn-M direct bond, the lengths of which are given in Table 4. The shortest distance here is for Sn-Ni with a value of 238.7(1) pm [146].

TABLE 3.
Summary of Mean Sn-M(non-transition) Distances Dimeric Heterometallic Tin Compounds.

Sn-M	Covalent Radius of M [pm]	Distances [pm] Shortest [ref]	Longest [ref]	Average
-Ge	122	253.7(6) [19]	261.06 [19]	260
-Zn	131	263.4(1) [30]		263
-Li	134	277.6(4) [6]	297(3) [9]	286
-Pb	147	280.9(2) [24]	284.8(2) [24]	283
-Tl	152	330.6(3) [18]		331
-K	196	346.0(4) [18]	354.8(3) [16]	350

Dimeric heterometallic tin chemistry is much richer than that of lead which had only eighteen similar examples [5]. In general, the shortest Sn-M distances compare to Pb-M distances according to their respective covalent radii (Sn = 141 pm and Pb = 147 pm). The values are: 250.8 vs 261.7 pm (M = Mn); 253.7 vs 262.1 pm (Ge); 248.6 vs 169.8 pm (Pt); 277.6 vs 285.8 pm (Li) and 275.7 vs 294.6 pm (V), respectively.

It is hoped that such an overview will help to focus attention on areas of tin chemistry that could be enhanced by further study, and assist in allowing comparative behaviour of the tin ion in the situations which can arise from the widespread use of tin.

TABLE 4.
Summary of Mean Sn-M(transition) Distances[a] in Dimeric Heterometallic Tin Compounds.

Sn-M	Covalent Radius of M [pm]	Distances [pm] Shortest [ref]	Longest [ref]	Average
-Ni	120	238.7(1) [146]	262.6(1) [148]	252.3
-Fe	120	240.8(1) [111]	262.43(21) [128]	253.4
-V	125	275.7(2) [38]	293.9(6) [39]	284.8
-Co	126	243.8(1) [137]	259.8(2) [143]	255.2
-Ru	126	254.3(1) [153a]	264.5(1) [157]	258.7
-Cr	127	256.0(3) [46]	275.1(1) [59]	265.8
-Pt	128	248.6(3)	265.39(6) [189]	256.6
-Pd	131	247.3(6) [165]	267.0(1) [166]	254.3
-Ti	132	284.3(1) [32]	292.1(1) [33]	288.2
-Rh	135	245.0(1) [159]	263.7(1) [153]	256.0
-Ir	137	258.67(6) [171]	292.0(2) [178]	265.5
-Nb	137	276.4(1) [42]	283.0(1) [44]	281.0
-Ta	138	275.2(1) [45]		275.2
-Au	143	288.1(1) [29]		288.1
-Mo	145	265.2(1) [62]	289.89(5) [77]	275.0
-Mn	146	250.8(3) [94]	270(1) [103]	262.2
-W	146	270.6(1) [80]	283.7(1) [90]	278.0
-Zr	148	306.1(2) [36]		306.1
-Re	159	260.9(1) [107]	279.3(1) [108]	267.2
-U[b]	142	316.6(1) [194		316.6

Footnote. *a. Only direct metal-metal bond data included. b. actinide metal.*

This data has been retrieved in large part by using the Cambridge Crystal database as a pointer to the original literature. However, some relevant material does get buried in the literature and is not visible from automated retrieval searches, and some is passed on in incorrect form from one paper to another, and even into the database. In this study the principle sources for original material have included CISTI in Ottawa (Canada), local university library holdings in south western Ontario, interlibrary loan facilities and the British Library in London (UK).

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