Synthesis and characterization of binuclear arylthiolato- and phenylselenolato-bridged organoplatinum(II) complexes: crystal structure of [Pt$_2$Ph$_2$(μ-SPh)$_2$(PMe$_2$Ph)$_2$]

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Abstract

Binuclear organoplatinum(II) complexes of the type [Pt$_2$Ar$_2$(μ-EAr$'$)$_2$(PR$_3$)$_2$] (Ar = Ph or *p*-tol; E = S or Se; Ar$'$ = Ph or *p*-tol; PR$_3$ = PPr$_3$ PBu$_3$ or PMe$_2$Ph) have been synthesized and characterized by elemental analysis and nuclear magnetic resonance (^{1}H and ^{31}P) spectroscopy. Some of these complexes were isolated exclusively as the *trans* isomer, but others were present at a mixture of *cis* and *trans* isomers. An X-ray diffraction study of [Pt$_2$Ph$_2$(μ-SPh)$_2$(PMe$_2$Ph)$_2$] has shown that it has *sym–trans* geometry, with a planar four-membered Pt$_2$S$_2$ ring.

Key words: Platinum; Thiolate; Selenolate; Aryl

1. Introduction

Binuclear complexes of platinum(II) of the type [Pt$_2$X$_2$(μ-Y)(μ-Z)(PR$_3$)$_2$] are of much current interest [1]. Compounds containing μ-ER bridges (E = S, Se or Te) offer many structural possibilities [2]. For example, the four-membered "Pt$_2$YZ" ring may adopt a planar or non-planar (bent or "butterfly") conformation (Scheme 1). As well as *cis* and *trans* isomerism, these complexes exhibit another type of geometrical iso-
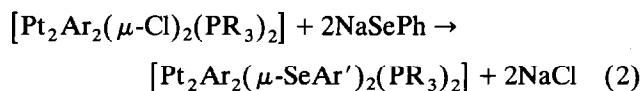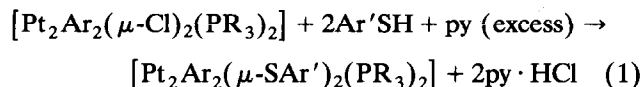
merism, namely *syn* and *anti*. For X = Cl, Y = Z = SR, it has been reported that alkylthiolato-bridged complexes prefer the *cis* geometry with a non-planar Pt$_2$S$_2$ conformation [3]. The arylthiolato-bridged palladium(II) complexes are found to be *trans* species, with a planar four-membered ring [4]. However, the complex [Pt$_2$Cl$_2$(μ-SPh)$_2$(Ptol$_3$)$_2$], despite having an arylthiolato bridge, exists as a mixture of *cis* and *trans* isomers [5]. Evidently subtle changes in the nature of the ligand trans to the thiolato group can determine the thermodynamically preferred configurations. We have now synthesized a series of complexes containing a strong *trans*-influencing X, an aryl group, *trans* to

bridging Y, Z (Y = Z = arylthiolato or phenylseleno-lato group) and characterized the resulting complexes by nuclear magnetic resonance (NMR) spectroscopy.

2. Results and discussion

Arylthiolato- and phenylselenolato-bridged dinu-clear organoplatinum(II) complexes of the type [Pt₂Ar₂(μ-EAr')₂(PR₃)₂] have been prepared by the following reactions:

$$[Pt_2Ar_2(\mu\text{-Cl})_2(PR_3)_2] + 2Ar'SH + py \text{ (excess)} \rightarrow$$

$$[Pt_2Ar_2(\mu\text{-SAr'})_2(PR_3)_2] + 2py \cdot HCl \quad (1)$$

$$[Pt_2Ar_2(\mu\text{-Cl})_2(PR_3)_2] + 2NaSePh \rightarrow$$

$$[Pt_2Ar_2(\mu\text{-SeAr'})_2(PR_3)_2] + 2NaCl \quad (2)$$

(where Ar = Ph or C₆H₄Me-4 (p-tol); Ar' = Ph or p-tol; PR₃ = P^{n}Pr₃ P^{n}Bu₃ or PMe₂Ph).

These complexes are cream to yellow air-stable crys-talline solids. They can exist in cis and trans forms. Some, notably the bridged p-tolS compounds, could be isolated exclusively as the trans isomers, while others gave mixtures of both isomers, with the trans form predominating. It has been reported that $^1J(^{195}Pt–^{31}P)$ values are larger for the cis isomer than for the trans form, whereas $^3J(^{195}Pt–^{31}P)$ is larger for the trans (about 50 Hz) than for the corresponding cis isomer (15–20 Hz) [5]. Although $^3J(^{195}Pt–^{31}P)$ values for the two isomers are not very different in the present case (24–32 Hz) (Table 1), the higher values of $^1J(Pt–P)$ and

$^3J(Pt–P)$ (about 30 Hz) are attributed to the cis isomer and smaller values of $^3J(^{195}Pt–^{31}P)$ (about 25 Hz) to the trans isomer.

The ^1H NMR spectra are consistent with the iso-meric forms deduced from ^{31}P NMR data. In general, the peak multiplicites and their integration are as expected. Each isomer of the complexes containing dimethylphenylphosphine exhibited a single doublet for PMe₂ protons, indicating a planar conformation of the four-membered "Pt₂E₂" ring. Complexes having a bent configuration, such as [Pt₂Cl₂(μ-X)(μ-SR)(PMe₂Ph)₂] (R = alkyl; X = Cl or SR) show two doublets for PMe₂ protons [5,6], whereas complexes with planar confor-mation, as in case of arylthiolato-bridged complexes [4], exhibit a single doublet for PMe₂ group [5]. Possi-bly the strong trans-influencing groups Ar or PR₃, trans to the bridging EAr' ligand, increases the rate of inversion at E (sulfur or selenium), leading to fluxional-ity in the molecule and resulting in a planar "Pt₂E₂" conformation.

The low temperature ^1H NMR spectrum of trans-[Pt₂Ph₂(μ-Stol)₂(PMe₂Ph)₂] was recorded in CD₂Cl₂ at 500 MHz. The spectrum did not change when the temperature was lowered to −60°C except for gradual shielding of the PMe₂ (δ = 1.20 (d) ppm at room tem-perature (RT); δ = 1.15 (d) ppm at −60°C), the methyl protons of the SC₆H₄CH₃-p (Stol) group (δ = 2.27 (s) ppm at RT; δ = 2.22 (s) ppm at −60°C) and the ortho protons of the Stol moiety (δ = 7.26 (d) ppm at RT; δ = 7.20 (d) ppm at −60°C). The changes in the chemi-cal shifts are too small (shielding of about 0.05 ppm at

Trans (M= Pd OR Pt)   Cis

syn   anti   anti   syn-endo   syn-exo

Planar   Non-Planar
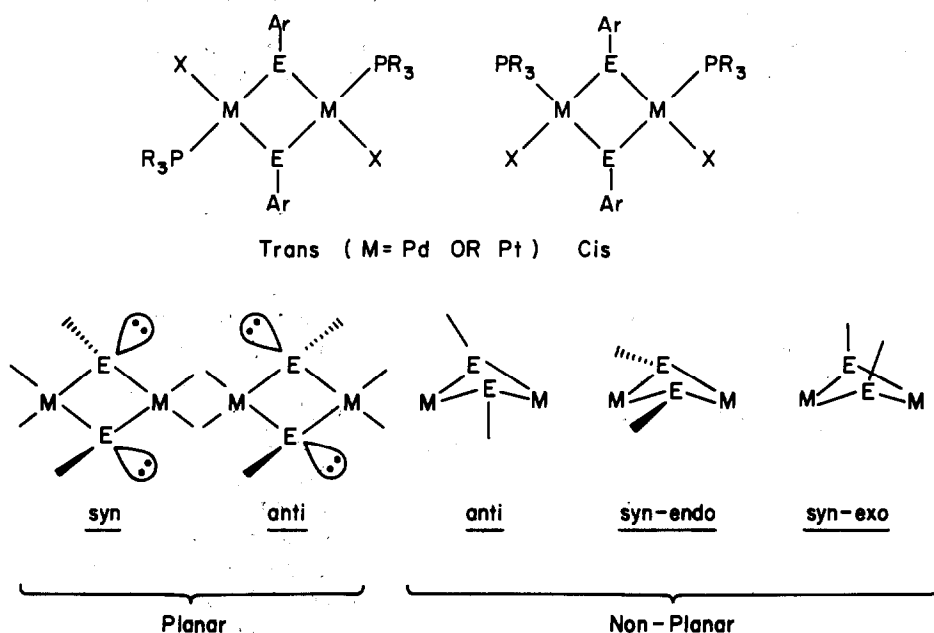
Scheme 1.

TABLE 1. ^{1}H and ^{31}P{^{1}H} nuclear magnetic resonance spectral data for [Pt$_2$Ar$_2$(μ-X)$_2$(PR$_3$)$_2$] in CDCl$_3$

Complex		^{31}P{^{1}H} NMR data			^{1}H NMR data ^{a},
		δ (ppm)	^1J (^{195}Pt–^{31}P) (Hz)	Other couplings (Hz)	δ (ppm)
[Pt$_2$Ph$_2$(μ-Cl)$_2$(PPr$_3$)$_2$]		0.8 ^{b} 0.3 ^{c}	4748 4757		0.90(br), 1.45(br)(Pr); 6.85(m), 7.25(m)(Ph)
[Pt$_2$Ph$_2$(μ-SePh)$_2$(PPr$_3$)$_2$]	trans	−0.8	3585	^3J(Pt–P) = 26	0.80(br), 1.30(m)(Pr); 6.50–8.00(m, Ph)
[Pt$_2$Ph$_2$(μ-Cl)$_2$(PBu$_3$)$_2$]		1.3 ^{b} 1.0 ^{c}	4754	–	0.90(br), 1.50(br)(Bu); 6.80–7.35 (br, m,ph)
[Pt$_2$Ph$_2$(μ-Stol)$_2$(PBu$_3$)$_2$]	trans	2.8	3555	^3J(Pt–P) = 24	0.80(br), 1.20(br)(Bu); 2.20(s, Me); 6.60–8.80(br, m, Ph + C$_6$H$_4$)
[Pt$_2$Ph$_2$(μ-SePh)$_2$(PBu$_3$)$_2$]	trans cis	0.1 ^{b} −0.7 ^{c}	3588 3606	^3J(Pt–P) = 25 ^3J(Pt–P) = 32 ^4J(P–P) = 6	0.78(br), 1.29(br)(Bu); 6.71–7.70(m, Ph)
[Pt$_2$tol$_2$(μ-Cl)$_2$(PBu$_3$)$_2$]	trans cis	1.3 ^{b} 0.9 ^{c}	4757 4770	–	0.85(br), 1.45(br)(Bu); 2.12(s, Me); 6.62–7.50(m, C$_6$H$_4$)
[Pt$_2$tol$_2$(μ-SePh)$_2$(PBu$_3$)$_2$]	trans cis	0.03 ^{b} −0.8 ^{c}	3597 3606	^3J(Pt–P) = 25	0.80(br), 1.25(br)(Bu); 2.05(s, Me); 6.50–7.60(m, Ph + C$_6$H$_4$)
[Pt$_2$Ph$_2$(μ-Cl)$_2$(PMe$_2$Ph)$_2$] ^{d}		−13.1	4875	–	1.54(d, J = 11Hz, PMe$_2$; ^3J(Pt–H) = 27 Hz) ^{b}; 1.58(d, J = 11 Hz, PMe$_2$; ^3J(Pt–H) = 27 Hz) ^{c}; 6.70–7.80(br, m, Ph)
[Pt$_2$Ph$_2$(μ-SPh)$_2$(PMe$_2$Ph)$_2$]	trans	−11.0	3642	^3J(Pt–P) = 25	1.21(d, J = 10.2 Hz, PMe$_2$; ^3J(Pt–H) = 25 Hz) ^{b}; 1.33(d, J = 10.2 Hz, PMe$_2$) ^{c}; 6.53–7.39(br, m, Ph)
[Pt$_2$Ph$_2$(μ-Stol)$_2$(PMe$_2$Ph)$_2$]	trans	−10.9	3616	^3J(Pt–P) = 25	1.21(d, J = 10 Hz, PMe$_2$; ^3J(Pt–H) = 41 Hz); 2.28(s, Me); 6.66–7.30(m, Ph + C$_6$H$_4$)
[Pt$_2$Ph$_2$(μ-SePh)$_2$(PMe$_2$Ph)$_2$]	trans cis	−14.0 ^{b} −13.5 ^{c}	3642 3722	^3J(Pt–P) = 25	0.98(d, J = 10.2 Hz, PMe$_2$; ^3J(Pt–H) = 21 Hz) ^{b}; 1.11(d, J = 10.2 Hz, PMe$_2$) ^{c}; 6.76–7.84(br, m, Ph)
[Pt$_2$tol$_2$(μ-Cl)$_2$(PMe$_2$Ph)$_2$]	trans cis	−13.7 ^{b} −13.9 ^{c}	4906 4940	–	1.52(d, J = 11 Hz, PMe$_2$; ^3J(Pt–H) = 27 Hz) ^{b}; 1.57(d, J = 11 Hz, PMe$_2$; ^3J(Pt–H) = 27 Hz) ^{c}; 2.20(br, s, Me); 6.65–7.80(br, m, Ph + C$_6$H$_4$)
[Pt$_2$tol$_2$(μ-SPh)$_2$(PMe$_2$Ph)$_2$]	trans cis	−11.2 ^{b} −10.6 ^{c}	3655 3738	^3J(Pt–P) = 25	1.20(d, J = 10.2 Hz, PMe$_2$; ^3J(Pt–H) = 21 Hz) ^{b}; 1.30(d, J = 10.2 Hz, PMe$_2$) ^{c}; 1.99(s, Me) ^{c}; 2.09(s, Me) ^{b} (ratio, 1:2.4); 6.38–7.40(m, Ph + C$_6$H$_4$)
[Pt$_2$tol$_2$(μ-Stol)$_2$(PMe$_2$Ph)$_2$]	trans	−11.2	3633	^3J(Pt–H) = 25	1.22(d, J = 10 Hz, PMe$_2$; ^3J(Pt–H) = 39 Hz); 2.11(s, Me, Pt tol); 2.28(s, Me, Stol); 6.50–7.31(m, Ph + C$_6$H$_4$)
[Pt$_2$tol$_2$(μ-SePh)$_2$(PMe$_2$Ph)$_2$]	trans ^{e} cis ^{e}	−13.9 ^{b} −13.5 ^{c}	3656 3738	^3J(Pt–P) = 24	1.32(d, J = 10.2 Hz, PMe$_2$; ^3J(Pt–H) = 21 Hz) ^{b}; 2.14(br, s, Me); 6.45–7.90(br, m, Ph + C$_6$H$_4$)
[Pt$_2$tol$_2$(μ-SePh)$_2$(PMe$_2$Ph)$_2$] ^{a}		−13.7	3658		

^{a} Recorded in CDCl$_3$; s, singlet; d, doublet; m, multiplet; br, broad. ^{b} Major isomer more than 70%. ^{c} Minor isomer less than 30%. ^{d} In CH$_2$Cl$_2$. ^{e} In C$_6$H$_6$ + C$_6$D$_6$.

−60°C) to be attributed to different conformations. However, small changes of about 0.25 ppm, in ^{19}F NMR chemical shifts for [Pt$_2$(μ-SCF$_3$)$_2$(PR$_3$)$_4$]$^{2+}$ complexes have been interpreted as due to *syn* and *anti* isomers [7].

To confirm the conclusions drawn from NMR data the structure of one representative complex was determined by X-ray diffraction. The molecular structure of [Pt$_2$Ph$_2$(μ-SPh)$_2$(PMe$_2$Ph)$_2$] deputed in Fig. 1, shows that the compound has a *sym–trans* configuration. The

coordination around each platinum atom is distorted square planar. The central four-membered "Pt₂S₂" ring is planar, in contrast with non-planar bridges found in cis-[Pt₂Cl₂(μ-SEt)₂(PPr₃)₂] [3], cis-[Pt₂(SBz)₂(μ-SBz)₂(PMePh₂)₂] [8] and [Pt₂(NO₂)₂(μ-SMe)₂(PPh₃)₂] [9]. There is a centre of inversion in the middle of this four-membered ring. The geometry around sulfur is distorted tetrahedral, with relevant angles as follows: Pt–S–Pt*, 97.2(1)°; Pt–S–C(1A), 104.9(5)°; Pt*–S–C(1A), 111.9(5)°. The phenyl groups of the SPh ligands adopt an *anti* configuration.

The Pt–S distance *trans* to phosphine (2.371(4) Å) is slightly shorter than that *trans* to phenyl although the difference is barely significant. The Pt–S distance *trans* to phosphine is in good agreement with the reported value [3,8,9]. Lengthening of the Pt–S bond *trans* to the phenyl group reflects the strong *trans* influence of the aryl group [10]. The Pt–S distances *trans* to C(1) and NO₂, known to be weaker *trans*-influencing ligands, are 2.27 Å [3,5] and 2.29 Å [9] respectively for thiolato-bridged platinum(II) complexes. The bond lengths Pt–P (2.232(4) Å) [3,5,8,9] and Pt–C (2.00(2) Å) [11] are in good agreement with the reported values. The average P–C distance (1.82(2) Å) is normal. The average C–C distance in the phenyl rings attached to phosphorus, sulfur and platinum is 1.39 Å, with individual values ranging between 1.33(2) and 1.45(2) Å.

The S–Pt–S* angle (Table 2) (82.8(1)°) is considerably smaller than the normal value, indicating strain in the four-membered ring. The Pt–S–Pt angle (97.2(1)°) is significantly larger than that reported for any thio-

lato-bridged palladium(II) and platinum(II) complex [3–5,8,9].

3. Experimental details

The complexes [Pt₂Cl₂(μ-Cl)₂(PR₃)₂] [12], cis-[PtCl₂(CH₂=CH₂)(PR₃)] [13], [Pt₂Ar₂(μ-Cl)₂(PR₃)₂] [14] and Me₃SnAr [15] were prepared as described previously, and gave satisfactory microanalyses. Methods and spectroscopic techniques are similar to those used previously [16].

3.1. Preparation of [Pt₂tol₂(μ-SPh)₂(PMe₂Ph)₂]

Pyridine (0.2 ml) was added to a dichloromethane solution of [Pt₂tol₂(μ-Cl)₂(PMe₂Ph)₂] (120 mg, 0.13 mmol) and the mixture was stirred for 30 min. Thiophenol (28 mg, 0.255 mmol) in benzene (5 ml) was then added and the mixture was stirred for 5 h at room temperature. The solvent was removed *in vacuo* and the residue extracted with dichloromethane. After evaporation of the extract, the residue was recrystallized from dichloromethane–ethanol to give cream crystals (95 mg (68%)). Other compounds were prepared similarly, and the pertinent data are summarized in Table 3.

3.2. Preparation of [Pt₂Ph₂(μ-SePh)₂(PMe₂Ph)₂]

To a vigorously stirred solution of NaSePh prepared from Ph₂Se₂ (42 mg, 0.135 mmol) in benzene–methanol by reduction with NaBH₄ as described previously [13], was added under nitrogen, a suspension of [Pt₂Ph₂(μ-Cl)₂(PMe₂Ph)₂] (121 mg, 0.135 mmol) in benzene (10 ml). The mixture was stirred at room temperature for 5 h and the solvents then evaporated off *in vacuo*. The residue was extracted with dichloromethane, the extract was filtered and concentrated to 5 ml, and 1 ml of

TABLE 3. Melting point and analytical data for [Pt₂Ar₂(μ-EAr')(PR₃)₂]

Complex [a]	Melting point (°C)	Analyses: found (calculated)	
		C	H
[Pt₂Ph₂(μ-SePh)₂(PPr₃)₂]	165–166	42.4 (42.9)	5.4 (5.3)
[Pt₂Ph₂(μ-Stol)₂(PBu₃)₂]	101–103	49.7 (50.2)	6.5 (6.6)
[Pt₂Ph₂(μ-SePh)₂(PBu₃)₂]	127–129	44.7 (45.7)	5.8 (5.9)
[Pt₂tol₂(μ-SePh)₂(PBu₃)₂]	115–117	46.6 (46.6)	6.2 (6.2)
[Pt₂Ph₂(μ-SPh)₂(PMe₂Ph)₂]	182–183	46.7 (46.2)	4.1 (4.1)
[Pt₂Ph₂(μ-Stol)₂(PMe₂Ph)₂]	203–204	47.2 (47.3)	4.3 (4.3)
[Pt₂Ph₂(μ-SePh)₂(PMe₂Ph)₂]	162–164	41.8 (42.4)	3.8 (3.7)
[Pt₂tol₂(μ-SPh)₂(PMe₂Ph)₂]	158–160	47.0 (47.3)	4.4 (4.3)
[Pt₂tol₂(μ-Stol)₂(PMe₂Ph)₂]	192–194	47.8 (48.3)	4.6 (4.6)
[Pt₂tol₂(μ-SePh)₂(PMe₂Ph)₂]	160–162	43.2 (43.4)	3.9 (4.0)

[a] All the complexes were recrystallized from dichloromethane–ethanol with a 55–80% yield.

TABLE 2. Selected bond distances and angles with estimated standard deviations for [Pt₂Ph₂(μ-SPh)₂(PMe₂Ph)₂] [a]

	Bond distance (Å)		Bond distance (Å)
Pt–S	2.371(4)	S–C(1A)	1.78(2)
Pt–S *	2.386(4)	P–C(1)	1.84(2)
Pt–P	2.232(4)	P–C(2)	1.82(2)
Pt–C(1B)	2.00(2)	P–C(1C)	1.81(1)

	Bond angle (°)		Bond angle (°)
S–Pt–S *	82.8(1)	Pt–P–C(1C)	115.4(4)
S–Pt–P	177.4(1)	Pt–P–C(2)	115.1(7)
S–Pt–C(1B)	89.7(4)	C(1)–P–C(1C)	102.8(7)
S*–Pt–P	98.5(1)	C(1)–P–C(2)	104.7(9)
S*–Pt–C(1B)	171.6(4)	C(1C)–P–C(2)	104.1(8)
P–Pt–C(1B)	89.2(4)	Pt–C(1B)–C(2B)	120(1)
Pt–S–Pt*	97.2(1)	Pt–C(1B)–C(6B)	120(1)
Pt–S–C(1A)	104.9(5)	P–C(1C)–C(2C)	122(1)
Pt*–S–C(1A)	111.9(5)	P–C(1C)–C(6C)	119(1)
Pt–P–Cl	113.3(6)		

[a] The symmetry element indicated by an asterisk (*) is 1 − x, 1 − y, 1 − z.

TABLE 4. Crystal data and refinement details for [Pt₂Ph₂(μ-SPh)₂(PMe₂Ph)₂]

Empirical formula	$C_{40}H_{42}S_2P_2Pt_2$
Formula weight	1039.03
Crystal dimensions (mm × mm × mm)	0.4×0.2×0.6
Crystal system	Monoclinic
Space group	$P2_1/n$ (No. 14)
a (Å)	9.802(2)
b (Å)	8.490(2)
c (Å)	22.788(4)
β (°)	97.93(2)
Z	2
D_c (g cm^{-3})	1.837
F_{000}	1000
μ (Mo Kα) (cm^{-1})	77.35
λ (Mo Kα) (Å)	0.71069
Number of data collected	3769
Number of unique reflections	3550 (R_{int} = 0.152)
Number of observations ($I > 3.00\sigma(I)$)	2420
Number of variables	293
R	0.065
R_w	0.071

ethanol was added. Slow evaporation afforded pale-yellow crystals (105 mg (67%)). Other complexes containing a bridging PhSe group were prepared similarly.

TABLE 5. Fractional coordinates and equivalent isotropic parameters for non-hydrogen atoms with estimated standard deviations in parentheses for [Pt₂Ph₂(μ-SPh)₂(PMe₂Ph)₂]

Atom	x	y	z	B_{eq} (Å^2)
Pt	0.34807(5)	0.42134(6)	0.45802(2)	2.53(2)
S	0.4963(4)	0.6411(4)	0.4551(2)	2.8(1)
P	0.2008(4)	0.2220(5)	0.4611(2)	3.2(2)
C(1)	0.023(2)	0.287(2)	0.4643(9)	4.6(8)
C(1A)	0.573(1)	0.614(2)	0.3895(6)	3.3(6)
C(1B)	0.240(1)	0.491(2)	0.3812(7)	3.5(6)
C(1C)	0.235(1)	0.094(2)	0.5249(6)	2.7(5)
C(2)	0.188(2)	0.088(2)	0.3981(8)	6(1)
C(2A)	0.520(2)	0.695(2)	0.3379(7)	5.2(9)
C(2B)	0.266(2)	0.422(2)	0.3272(7)	4.8(8)
C(2C)	0.174(2)	0.118(2)	0.5762(7)	3.4(6)
C(3A)	0.581(2)	0.684(3)	0.2871(9)	7(1)
C(3B)	0.199(2)	0.475(3)	0.2723(9)	6(1)
C(3C)	0.208(2)	0.022(2)	0.6251(9)	4.4(8)
C(4A)	0.698(2)	0.587(3)	0.2885(9)	7(1)
C(4B)	0.111(2)	0.597(3)	0.2709(9)	7(1)
C(4C)	0.302(2)	−0.094(2)	0.6233(8)	4.5(7)
C(5A)	0.753(2)	0.511(3)	0.338(1)	6(1)
C(5B)	0.087(2)	0.671(3)	0.322(1)	6(1)
C(5C)	0.364(2)	−0.120(2)	0.576(1)	4.7(8)
C(6A)	0.694(2)	0.517(2)	0.3908(9)	5.2(9)
C(6B)	0.152(2)	0.618(2)	0.3803(8)	4.3(8)
C(6C)	0.329(2)	−0.029(2)	0.5243(8)	4.0(7)

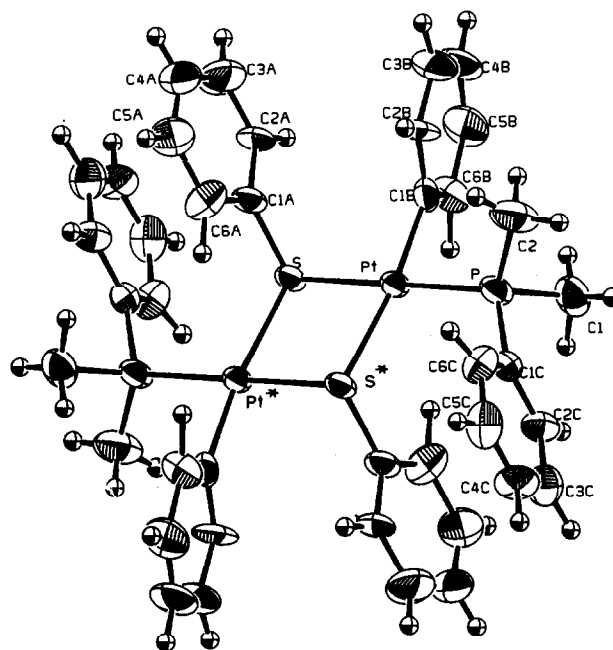## 3.3. Crystallography

Intensity data were collected from transparent prismatic crystal of $C_{40}H_{42}S_2P_2Pt$ at RT on a Rigaku AFC6S diffractometer fitted with graphite-monochromated Mo Kα radiation using an ω scan technique to a maximum 2θ value of 50.0°. Crystal data and refinement details are given in Table 4, and fractional atomic coordinates are listed in Table 5.

Three representative reflections were monitored after every 150 reflections and were unchanged throughout. Thus no decay correction was applied. Based on azimuthal scans of several reflections an empirical absorption correction was applied, resulting in transmission factors ranging from 0.30 to 1.00. The data were corrected for Lorentz and polarization effects.

The structure was solved by direct methods [17]. The non-hydrogen atoms were refined anisotropically. The final cycle of full-matrix least-squares refinement converged with unweighted and weighted agreement factors of R $(= \Sigma||F_o|-|F_c||/\Sigma|F_o|) = 0.065$ and R_w $(= [\Sigma_w(|F_o|-|F_c|)^2/\Sigma_w(F_o)^{1/2}]) = 0.071$.

Neutral atom scattering factors were taken from the work of Cromer and Waber [18]. Anomalous dispersion effects were included in F_c [19]; the values for $\Delta f'$ and $\Delta f''$ were those of Cromer [20]. All calculations were performed using the TEXSAN [21] crystallographic software package of the Molecular Structure Corporation. An ORTEP [22] plot of the molecule is shown in Fig. 1. Tables of thermal parameters, and hydrogen atom co-

Fig. 1. ORTEP plot of [Pt₂Ph₂(μ-SPh)₂(PMe₂Ph)₂] with numbering scheme for non-hydrogen atoms.

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