Organodiphosphines in Monomeric PtP₂X₂ (X = OL, NL, CN, BL) Derivatives Structural Aspects

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ABSTRACT

In this review are classified and analyzed structural parameters of over seventy examples of monomeric PtP₂X₂ (X = OL, NL, CN or BL) derivatives in which P donor ligands are organodiphosphines. These complexes crystallize in four crystal systems: tetragonal (x1), triclinic (x11), orthorhombic (x19) and monoclinic (x40). The complexes were divided into the two groups: Pt(η²-P₂L)(XL)₂ (X = O, N, CN or B) and Pt(η²-P₂L)(η²-X₂L) (X = O or N). The chelating ligands create wide of metallocyclic rings and the effects of both steric and electronic factors influence on the values of L-Pt-L bite angles. The some cooperative effects were found and are discussed with trans-influence of the respective donor atoms.

Keywords: Structure, organodiphosphine, PtP₂X₂ (X = OL, NL, CN, BL), review

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Introduction

Due to the usefulness of platinum and its compounds considerable research activity has been invested in their synthesis and properties. This has included a considerable number of structural determinations which have helped to shed light on biological and other activity. Platinum exists in a wide range of oxidation states from zero to six, of which +2 and +4 are the most common, particularly in coordination chemistry. Structural parameters of over two thousand and five hundred platinum coordination complexes have been reviewed by us [1]. Recently we classified and analyzed structural parameters of stereoisomers of platinum coordination complexes [2]. Included are distortion (65%) cis-trans (30%), mixed isomers and ligand isomerism.

The aim of this review is to classify and analyze structural parameters of monomeric coordination complexes of platinum with an inner coordination spheres of PtP₂X₂ (X = OL, NL, CN, BL) in which P donor ligands are organodiphosphines. The primary source of information was Cambridge Crystallographic Database up to the end of october 2017.

Cis-PtP₂X₂ derivatives

There are over seventy examples of monomeric PtP₂X₂ (X = O, N, CN or B) complexes for which structural parameters are available and analyze in this paper.

There are almost forty derivatives with the PtP₂O₂ chromophore. On the basis of coordination mode of the respective donor ligands these derivatives can be divided into the two sub-groups: Pt(η²-P₂L)(OL)₂ and Pt(η²-P₂L)(η²-O₂L). These complexes crystallize in four crystal systems: tetragonal (x 1), triclinic (x 6), orthorhombic (x 12) and monoclinic (x 18).

There are thirteen examples with the cis-Pt(η²-P₂L)(OL)₂ type. The structures are referred in the order of an increasing number of hetero-atoms in the P,P chelate rings. Such complexes are: [Pt(η²-Ph₂PCH₂PPh₂)(F₃CCOO)₂] [3], [Pt(η²-Ph₂PN(Me)PPh₂)(ONO₂)₂] [4], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(H₂O)] [5], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(H₂O)(OSO₂CF₃)₂] [6], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(OEt)] [7], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(ONOO₂)] [8], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(OSO₂CF₃)] [9] (monoclinic [10], [Pt(η²-Pr₂P(CH₂)₂PPr₂)(acetate)] [11], [Pt(η²-Pr₂P(CH₂)₂PPr₂)(benzoate)] [12], [Pt(η²-Ph₂P(CH₂)₂PPr₂)(benzoate)] [13,14]. Structure of [Pt(η²-Pr₂P(CH₂)₂PPr₂)(benzoate)] [11] is shown in Fig. 1 as an example. The chelating P,P ligands plus two monodentate O donor ligands create cis-PtP₂O₂ chromophore. The chelating ligands form variety of metallcyclic rings with the mean values of P-Pt-P bite angles of 74.1º (PCP) [3], 70.0º (PNP) [4,5], 86.6º (PC₂P) [6-12] and 100.4º (PC₄P) [13,14]. The mean values of the remaining L-Pt-L bond angles are 85.8º(O-Pt-O), 95.5º and 175.0º(P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O). The mean values of the remaining L-Pt-L bond angles are 85.8º (O-Pt-O), 95.5º and 175.0º (P-Pt-O).
Figure 1. Structure of $[\text{Pt}(\eta^2-\text{Pr}_2\text{CH}_2\text{Pr}_2\text{PPr}_2)\text{benzoate})_2]^1$

Figure 2. Structure of $[\text{Pt}(\eta^2-\text{Ph}_2\text{PCH}_2\text{PPh}_2)\{\eta^2-\text{oxalate}\}]^{15}$
Figure 3. Structure of Pt\{\eta^2-\text{Ph}_2\text{P}(\text{CH}_2)_4\text{PPh}_2\}{\eta^2-\text{O}_9\text{P}_3}\}^- \quad [21]

Figure 4. Structure of [Pt\{\eta^2-\text{Ph}_2\text{P}(\text{CH}_2)_3\text{PPh}_2\}(\text{NC}_6\text{H}_7)_2]^{2+} \quad [39]
OCH₂CH(O)CH₂OH].2MeOH [16], [Pt(η²-cy₂P(CH₂)₂Pcy₂){η²-oxalate}].MeCN [17], [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-C₂H₄O₂}].CHCl₃ [18], [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-C₂H₁₀O₂}].MeCN [19], [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-C₁₂H₁₀B₃O₃}]. [20], [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-C₂H₁₄B₂O₅}]. [20], (PPh₄)₂[Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-OSP₃}].MeCN [21], [Pt(η²- Ph₂P(CH₂)₂PPh₂){η²-C₂H₁₀O₂}].CH₂Cl₂ [22], [Pt(η²-Ph₂PCH(Me)₂CHPPh₂){η²-C₂H₁₀O₂}]. [22], [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-C₂H₁₄B₂O₅}].CH₂Cl₂ [23], and [Pt(η²-Ph₂P(CH₂)₂PPh₂){η²-squ}].MeCN [24], the homobidentate P,P-donor ligands create five-membered metallocyclic rings (PC₂P) [12,16-24] and together with five- (OC₂O) [12,16-19], six-(OBOBO) [20], (OPOPO) [21], and seven-(OC₄O) [22-24] membered rings build up a distorted square planar environment about each Pt(II) atom. The mean values of the respective metallocyclic rings are: 87.3° (PC₂P) [12,16-24], 81.5° (OC₂O) [12,16-19], 91.2° (OBOBO) [20], 89.8° (OPOPO) [21] and 90.3° (OC₄O) [22-24].

In another six examples: [Pt(η²-Ph₂P(CH₂)₃PPh₂){η²-O₂CO}]. [25], [Pt(η²-Ph₂P(CH₂)₃PPh₂){η²-O₂CO}].CH₂Cl₂ [25], [Pt(η²-cy₂P(CH₂)₃Pcy₂){η²-O₂CO}].toluene [26], [Pt(η²-Ph₂P(CH₂)₃PPh₂){η²-oxalate}]. [27], [Pt(η²-Ph₂P(CH₂)₃PPh₂){η²-malonate}] [28], and [Pt(η²-Ph₂P(CH₂)₃PPh₂){η²-C₄H₄NO₄}].CH₂Cl₂ [29], homobidentate P,P donor ligands creates six-membered metallocyclic rings (PC₃P) and together with homobidentate O,O donor ligands with four-(OCO) [25,26], five-(OC₂O) [27], six-(OC₃O) [28] and even eight-(OC₅O) [29] membered metallocyclic rings completed cis-PtL₂O₂ chroomophores. The mean values of the respective metallocyclics are: 95.8° (PC₃P) [25-29], 66.0° (OCO) [25,26], 82.0° (OC₂O) [27], 90.1° (OC₃O) [28] and 95.3° (OC₅O) [29].

In remaining six complexes: [PPh₃N][Pt(η²-Ph₂P(CH₂)₄PPh₂){η²-OSP₃}].MeCN [0.5CH₂Cl₂ [21], [Pt(η²-Ph₂P(C₁₂H₁₈)₂PPh₂){η²-C₂H₁₀O₂}].CH₂Cl₂ [30], [Pt(η²-Ph₂P(C₁₂H₂₂)₂PPh₂){η²-C₂H₁₂O₂}].toluene [31], [Pt(η²-Ph₂P(C₂₀H₁₈)₂PPh₂){η²-C₂H₁₂O₂}].toluene [32], [Pt(η²-Ph₂P(C₂₀H₁₂)₂PPh₂){η²-C₂H₁₀O₂}].CH₂Cl₂ [32], and [Pt(η²-Ph₂P(C₂₀H₁₈)₂PPh₂){η²-C₂H₁₂O₂}].CHCl₃ [32], homobidentate P,P donor ligands creates seven-(PC₄P) membered rings and together with six-(OPOPO) [21] and seven-(OC₄O) [30-32] membered metallocyclic rings completed cis-PtL₂O₂ chroomophore. Structure of Pt(η²-Ph₂P(CH₂)₄PPh₂){η²-O₅P₃}⁺ [21] is shown in Fig. 3 as an example. The mean values of the respective metallocycles are: 100.5° (PC₄P) [21,30-32], 91.3° (OPOPO) [21], and 89.8° (OC₄O) [30-32].

There are cooperative effects between cis-Pt-Pt-P (metallocycle) and cis-Pt-O bond angles, the former uncoils with the growing size of the metallocycle and the latter closes as expected. The mean values of cis-Pt-P and cis-Pt-O are: 74.0° (PCP) and 102.7° (P-Pt-O); 86.8° (PC₂P) and 94.8° (P-Pt-O); 95.8° (PC₃P) and 91.5°(P-Pt-O); 100.4° (PC₄P) and 84.5° (P-Pt-O). The trans-Pt-O bond angles range from 164.0° to 178.0°. The mean values of Pt-L bond distances are 2.06 Å (O, trans to P) and 2.215 Å (P, trans to O).

There are twenty five examples with the PtL₂N₂ chroomophore. These complexes on the basis of the coordination mode of the respective donor ligands can be divided into the two groups: Pt(η²-P₂L)NL₂ and Pt(η²-P₂L)(η²-N₂L). These complexes crystallize in three crystal systems: triclinic (x 3), orthorhombic (x 7) and monoclinic (x 15).

There are eighteen complexes of the cis-Pt(η²-P₂L)(NL₂) type. The structures are referred in the order of an increasing numbers of heteroatoms in the P,P-metallocycles. Monoclinic (P₂₃n) Pt(η²-(PhO)₂PNP(OPh)₃)(NC₆H₁₁)₂(F₃COSO)₃ [5] is only example in which homobidentate P,P donor ligand creates four-membered metallocyclic ring with the value of P-Pt bite angle of 70.5° (PNP) and pair of monodentate N donor ligands completed a distorted square planar environment, cis-PtL₂N₂.
Figure 5. Structure of [Pt(η²-Ph₂P(CH₂)₂PPh₂)(η²-N₂C₂₁H₂₀O₂S)] [45]

Figure 6. Structure of [Pt(η²-Ph₂P(C₈H₁₂)PPh₂){η²-N₂C₁₄H₁₆}]²⁺ [47]
Figure 7. Structure of \([\text{Pt} \{\eta^2-\text{Ph}_2\text{PCH}_2\text{N(Ph)}\text{CH}_2\text{PPh}_2\}(\text{CN})_2]\) \cite{51}

Figure 8. Structure of \([\text{Pt} \{\eta^2-\text{cy}_2\text{P(CH}_2)_2\text{Pcy}_2\}\{\text{B(NMe}_2\text{)Br}\}_2]\) \cite{52}
In four examples: [Pt(η²-Ph₂P(CH₂)₂PPh₂)(3,5-Me₂pz)z] [33], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(3,5-Me₂pzH)₂](BF₄)₂.CH₂Cl₂ [34], [Pt(η²-Ph₂P(CH₂)₂PPh₂)(p-O₂NC₆H₄SNSN₂)z] [35] and [Pt(η²-Ph₂P(CH₂)₂PPh₂)(pz)z](BF₄)₂.CHCl₃.H₂O [36] homobidentate P,P donor ligands create five-membered metallacyclic rings with the mean P-Pt-P bite angles of 85.8° (PC₄P). Two monodentate N donor ligands completed a distorted square planar environment about the Pt(II) atom (cis-PtP₂N₂). The mean values of P-N bond angle is 94.9(2)° (PC₄P). Two NO₂ groups completed a distorted square planar environment about the Pt(II) atom (cis-PtP₂N₂). The value of P-N bond angle is 84.6(7)°. The mean values of P-L bond distances are 2.11 Å (N, trans to P) and 2.268 Å (P, trans to N).

There are eight examples of the cis-Pt(η²-PzL)(η²-N₂L) type. The ligand arrays can be subdivided into the three groups: monoclinic [Pt(η²-Ph₂PCH₂PPh₂)((η²-N₂C₆H₄)(PC₄P)z) [42] is only example in which chelating P,P donor ligand creates four-membered metallacycle with the value of P-Pt-P bite angle of 74° (PCP). The chelating N,N donor ligand creates five-membered metallacycle with the value of N-Pt-N bite angle of 82° (NC₂N) and completed a distorted square planar environment about the Pt(II) atom (cis- PtP₂N₂).

In another four complexes: [Pt(η²-Ph₂P(CH₂)₂PPh₂)(η²-sulfonamide)]CH₂Cl₂ [43], [Pt(η²-Ph₂PCH(Me)CH(Me)PPh₂)(η²-N₂C₆H₄)((PF₆)z), 1.8CH₂Cl₂] [44], [Pt(η²-Ph₂PCH(Me)CH(Me)PPh₂)[η²-N₂C₆H₄](CF₃CO₂)H] [45] is shown in Fig. 5 as an example. The mean values of remaining L-Pt-L bond angles of 84.6° (PC₄P) and 78.9° (NC₂N). Structure of [Pt(η²-Ph₂P(CH₂)₂PPh₂)(η²-N₂C₆H₄)(CF₃CO₂)H] [45] is shown in Fig. 5 as an example. The mean values of remaining L-Pt-L bond angles are 98.3° and 175.7° (P-Pt-N). The mean values of P-L bond distances are 2.11 Å (N, trans to P) and 2.254 Å (P, trans to N).

In the remaining three examples: [Pt(η²-Ph₂P(C₁₂H₁₈)PPh₂)(η²-N₂C₆H₄)(PC₄P)] [45] each chelating P,P donor ligand creates seven-membered metallacycle with the mean P-Pt-P bite angle of 92.5° (PC₄P) and each chelating N,N donor ligand creates five-membered metallacycle with the mean N-Pt-N bite angle of 94.9° (PC₄P). Two NO₂ groups completed a distorted square planar environment about the Pt(II) atom (cis-PtP₂N₂).
81.5° (NC\textsubscript{2}N). Structure of $[\text{Pt}(\eta^2\text{-Ph}_2\text{P(C}_6\text{H}_12\text{)}\text{PPh}_2\{\eta^2\text{-Nc}_6\text{C}_14\text{H}_16\})]^{2+}$ [47] is shown in Fig. 6 as an example. The values of remaining L-Pt-L bond angles are 93.5° and 175.5° (P-Pt-N). The values of Pt-L bond distances are 2.10 Å (N, trans to P) and 2.268 Å (P, trans to N).

There are four monoclinic examples with the cis-Pt(\eta^2\text{-P}_2\text{L})(\text{CN})\text{_2} type. The chelating P,P ligand arrays can be subdivided into the three groups. In $[\text{Pt}(\eta^2\text{-Ph}_2\text{PCH}_2\text{PPh}_2\{\text{CN}\text{_2}\})]$ [49] the chelating P,P donor ligand creates four-membered metallocycle with the P-Pt-P bite angle of 70.7° (PCP). In $[\text{Pt}(\eta^2\text{-Ph}_2\text{PCH}_2\text{N}(\text{Ph})\text{CH}_2\text{PPh}_3\{\text{CN}\text{_2}\})]$ (Fig. 7) [51] the chelating ligand creates six-membered metallocycle 90.2° (PCNCP). The mean values of L-Pt-L bond angles are 93.8° (C-Pt-C) and 88.4° (P-Pt-C). The mean values of Pt-L bond distances are 2.00 Å (C, trans to P) and 2.335 Å (P, trans to C).

There are five examples with the Pt(\eta^2\text{-P}_2\text{L})(\text{BL})\text{_2} type. The chelating P,P donor ligand arrays can be subdivided into the three groups. In monoclinic $[\text{Pt}(\text{cy}_2\text{PCH}_2\text{Pcy}_2\{\text{B(NMe}_2\text{_2)}\text{Br}_2\})]$ [52] the chelating P,P donor ligand creates four-membered metallocycle with the P-Pt-P bite angle of 73.8° (PCP) and pair of monodentate B donor ligands build up a distorted square planar environment about the Pt(II) atom (cis-PtP\text{_2}B\text{_2}). In another monoclinic $[\text{Pt}(\text{cy}_2\text{P}(\text{CH}_2)_2\text{Pcy}_2\{\text{B(NMe}_2\text{_2)}\text{Br}_2\})\text{toluene}]$ [52] and triclinic $[\text{Pt}(\eta^2\text{-Ph}_2\text{P(CH}_2\text{)}\text{PPh}_2\{\text{B(1,2-O}_2\text{C}_6\text{H}_4\text{)}\text{_2}\})]$ [53] each chelating P,P donor ligand creates five-membered metallocycle with the P-Pt-P bite angle of 85.4° (PCP). In remaining two complexes, monoclinic $[\text{Pt}(\eta^2\text{-Ph}_2\text{P(CH}_2\text{)}\text{PPh}_2\{\text{B(1,2-O}_2\text{C}_6\text{H}_4\text{)}\text{_2}\})]$ [53] and triclinic $[\text{Pt}(\eta^2\text{-Ph}_2\text{P(CH}_2\text{)}\text{PPh}_2\{\text{BF}_2\text{_2}\})]$ [41] the chelating ligand creates seven-membered metallocycle with the mean P-Pt-P bond angles of 98.2° (PCP). Structure of $[\text{Pt}(\text{cy}_2\text{P}(\text{CH}_2)_2\text{Pcy}_2\{\text{B(NMe}_2\text{_2)}\text{Br}_2\})]$ [52] is shown in Fig. 8 as an example. The mean values of L-Pt-L bond angles are 79.7° (B-Pt-B), 94.0° and 169.4° (P-Pt-B). The mean values of Pt-L bond distances are 2.045 Å (B, trans to P) and 2.332 Å (P, trans to P).

**Conclusions**

There are over seventy examples of monomeric Pt(II) complexes with cis-PtP\text{_2}X\text{_2} inner coordination. The P donor ligands are organodiphosphines and X donor ligands are OL (37 examples), NL (25 examples), CN (4 examples) or BL (5 examples). These complexes crystallize in four crystal systems: tetragonal (x 1), triclinic (x 11), orthorhombic (x 19) and monoclinic (x 40). On the bases of coordination mode of the respective donor ligands these complexes can be divided into the two sub-groups: Pt(\eta^2\text{-P}_2\text{L})(XL)\text{_2} (X = O, N, CN or B) and Pt(\eta^2\text{-L})(\eta^2\text{-X}_\text{2L}) (X = O or N). The total mean Pt-P (trans to X) bond distances elongate in the order: 2.215 Å (X = O) < 2.260 Å (N) < 2.332 Å (B) < 2.335 Å (C). The total mean Pt-X (trans to P) elongate in the order: 2.01 Å (X = C) < 2.04 Å (B) < 2.075 Å (O) < 2.09 Å (N). The sum of all four (Pt-P(x2)+Pt-X(x2)) bond distances growing quite well with covalent radii of X atoms in the order: 8.58 Å (X = O, 0.73 Å) < 8.70 Å (N, 0.75 Å) < 8.75 Å (B, 0.82 Å).

The chelating P,P; O,O and N,N donor ligands create variations of the metallocycles and the effects of both steric and electronic factors can be seen from the mean values of the L-Pt-L bite angles, which open in the orders: P-Pt-P: 70.0° (PNP) < 74.0° (PCP) < 86.8° (PCP) < 95.8° (PC3P) < 100.4° (PC4P); O-Pt-O: 66.0° (OCO) < 81.3° (OC2O) < 90.0° (OC3O). OC4O < 90.5° (OPOPO) < 91.2° (OBONO) < 95.8° (OC4O);N-Pt-N: 78.9° (NC2N, unsaturated) < 81.5° (NC2N, saturated).

In the series of Pt(\eta^2\text{-P}_2\text{L})(\eta^2\text{-O}_2\text{L}) complexes is cooperative effect between cis-P-Pt-P (metallocycle) and cis-P-Pt-O bond angles (mean values). The former unclose and the latter close: 74.0° (PCP) and 102.7°; 86.8° (PC2P) and 94.8°; 95.8° (PC3P) and 91.5°; 100.4° (PC4P) and 84.5°.
In the series of \( \text{PtCl}_2(XL)_2 \) complexes, the cooperative effect between cis-X-Pt-X and P-Pt-X bond angles (Nachtigal values). The former is unclosed and the latter closed at 79.7° and 94.0° (X = B); 85.8° and 93.5° (X = O); 87.1° and 93.0° (X = N); 93.8° and 94.0° (X = C).

During the collection and organization of the data, it has become visible that in spite of the increasing availability of data retrieval systems, the trucking of relevant structural data is not always simple. Poorly chosen key words for indexes appear to be a problem which results in effective invisibility of some information from a structural point of view. Some original papers are lacking important information such as atomic coordinates and analysis of intermolecular distances. Increasingly such data are also being relegated to supplementary material. In view of these limitations we believe that a review such as this can continue to serve a useful function by centralizing available material and delineating areas worthy of further investigation. Related review of cis-PtP\(_2\)Cl\(_2\) derivatives in which P(C,H\(_2\))\(_2\)ligands are organophosphines is in progress.

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Abbreviations

\( \text{PtH}_2\text{PCl}_2(\text{H}_2\text{O})_2 \) 
1,3-diphenyl-1,3-dibora-2-oxapropane-1,3-diolate 
1,3-bis((4-acetylatedeny)-1,3-dibora-2-oxopropano-1,3-diolate
\( \text{C}_{14}\text{H}_{20}\text{O}_2 \) 
3,5-di-terc-butylbenzene-1,2-diolate
2,2'-binaphthyln-1,1'-dilolate
\( \text{C}_{20}\text{H}_{14}\text{O}_6 \) 
3,4-bos(benzylxoy)-5-(1,2-dioxoethyl)furan-2(5H)-one
3,3'-diphenyl-2,2'-binaphthyln-1,1'-dilolate
5,11,17,23-tetra-tertiobutyl-27,28-dihydroxypentacyclo
[19.3.1.1.7.7.13.15.18]octacosa-
(25),3,5,7(28),9,11,13(27), 15,17,19(26),21,23-dipdecaeme25,26-diolate
3,5-dimethylpyrazol-2-yl

2,2'-bipyridine
1,10-phenanthroline
1,2-diphenylethane-1,2-diamine
2-amido-1,2-diphenylethyl-1-p-toluene-sulfonamidate
2-aminopyridine
N,N-dimethylpyridin-4-amine
(pyridine-4-yl)acetamide
4-phenylpyridine
4-methylpyridine
4-acetylpyridine
4-methoxy pyridine
2,6-dimethylaniline
4-terc-butylpyridine
cyclotriphasphate
2,2'-bis(diphenylphosphino)1,1'-biphenyl
2,2'-bis(diphenylphosphino)-1,1'-biphenyl
PhosphP(C\(_{20}\)H\(_{12}\))PPh\(_2\) 1,1'-binaphtaltenone
2,2'-diylbis(diphenylphosphine)
1,2-bis(diphenylphosphino)phenylmethylenecyclohexane
1,4-bis(diphenylphosphino)1,2,3,4-tetraphylenedimethyl-1,3-butadiene
1,2-bis(diphenylphosphino)benzene
PhosphP(C\(_{20}\)H\(_{12}\))PPh\(_2\) 1,2-
bis(diphenylphosphino)1,2,3,4-tetramethyl-1,3-butadiene
2,5-bis(diphenylphosphino)-3,4-dimethylhexa-2,4-diene
1,2-bis(1-diphenylphosphino)prop-1-ylidene
cyclohexane
N,N-bis((diphenylphosphino)methyl)niline
PhosphP(Me\(_2\))PPh\(_2\) bis(diphenylphosphino)methylamine
(Ph\(_2\))\(_2\)P(Me\(_2\))PO\(_2\) 1,1,3,3-tetakis(phenoxyl)-2-methylphosphazane
pyrazol-2-yl silasesquinoxanate

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Platinum Complexes of Conformationally Flexible Macromolecules

NCA Initiated by Platinum Complexes of Platinum(IV) complexes of Nickel(II), palladium(II), platinum(II) and platinum(II)−Bis(boryl) Catalyst Precursors for Chloroform Transfer and Intraligand Charge Transfer and Intraligand Charge Transfer and Intraligand Charge Transfer


Lesley, G.; Nguyen, P.; Taylor, N.J.; Marder, T.B.; Scott, A.J.; Clegg, W.; Norman, N.C. Synthesis and Characterization of Platinum(II)–Bis(boryl) Catalyst Precursors for Diboration of Alkenes and Diynes: Molecular Structures of cis-[(PPh3)2Pt(B-4-Bu’cat)2], cis-[(PPh3)2Pt(Bcat)2], cis-[(dppe)Pt(Bcat)2], cis-[(dppe)Pt(Bcat)2], cis-[(dppe)Pt(Bcat)2], (E)-(4-MeOC6H4)C(=CH)(Bcat)=CH(Bcat), (Z)-(4-MeOC6H4)C(=CH)(Bcat)=CH(Bcat), (Z,Z)-(4-MeOC6H4)C(=CH)(Bcat)=CH(Bcat) and PhPCH2CH2PPh2. Organometallics. 1996, 15, 5137-5154.

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