Available online at www.sciencedirect.com

SCIENCE DIRECT®

Journal of Organometallic Chemistry 663 (2002) 78–82

Journal of Organo metallic Chemistry

www.elsevier.com/locate/jorganchem

Mono-indenyl and cyclopentadienyl derivatives of molybdenum(IV) with a 16 valence-electron configuration

Carlos C. Romão *, Beatriz Royo

Instituto de Tecnologia Química e Biológica da Universidade Nova de Lisboa, Quinta do Marquês, EAN, Av. da Republica, Apartado 127, 2781-901 Oeiras, Portugal

Received 16 May 2002; accepted 3 June 2002

Abstract

Reactions of (ring)$MoCl_3$ [ring = cyclopentadienyl, η^5-C_5H_5 (Cp) and indenyl η^5-C_9H_7 (Ind)] with salts of the *N*,*N*-diethyldithiocarbamate $(S_2CNEt_2)^-$, *O*,*O′*-diethyldithiophosphate $[S_2P(OEt)_2]^-$, *N*,*N′*-diphenylformamidinate $[CH(NPh)_2]^-$, acetate $(O_2CCH_3)^-$ and acetylacetonate $[CH_3COCH(O)CH_3]^-$ $(acac)^-$ anions yield the molybdenum(IV) complexes of the type (ring)$MoCl_2X$. Characterisation of new compounds by elemental analysis, IR and ^{1}H-NMR spectroscopy and magnetic susceptibility measurements is discussed.

Keywords: Indenyl; Cyclopentadienyl; Molybdenum; Dithiocarbamate; Dithiophosphate; Amidine; Acetylacetonate; Acetate

1. Introduction

To date, the chemistry of monocyclopentadienyl molybdenum(IV) complexes and its ring-substituted analogues remains relatively undeveloped and can be confined to a handful of compounds. Without being exhaustive, we believe that the earlier examples are the dicarbonyls $CpMoX_3(CO)_2$ (X = Cl, Br, I) obtained by X_2 oxidation of either $Cp_2Mo_2(CO)_6$ or $CpMo(CO)_3X$ [1]. The cyanide derivative $CpMo(CN)_3(CO)_2$ was obtained by CN^- substitution on the parent iodide [2]. Related phosphine derivatives, $CpMoX_3L_2$ (L_2 = dppe, dmpe; L = PMe_3, PMe_2Ph; X = Cl, Br, H) were also reported by the group of Green [3]. The trihydrides with L = dmpe, PMe_3, PMe_2Ph induce catalytic H/D exchange in sp^3 and sp^2 C–H bonds under photolytic conditions [4]. However, the synthesis of the simple derivatives $CpMoX_3$ (X = Cl, Br or I) [5] and (η^5-C_5Me_5)$MoCl_3$ by Poli and coworkers [6], is considerably more recent. It comprises a variety of synthetic methods (oxidation of $CpMCl_2$; reduction of $CpMCl_4$ and conproportionation of $CpMCl_2$ and $CpMCl_4$ and covers a number of phosphine adducts of the type $Cp'MX_3L$ and $Cp'MX_3L_2$ (L = dppe [7], dmpe [7] and PMe_2Ph [4]) either as the chlorides or hydrides. The more exotic $Cp^*MoHCl(PPh_2)(PMe_3)$ also belongs to this family [8], as well as $[CpMoCl_4]^-$ [9] and the related family of thiolates, $[CpMo(SR)_4]^-$, e.g. $[CpMo\{S_2C_2(CN)_2\}_2]^-$ [10] and $[CpMo\{SC_6F_5\}_4]^-$ [11]. Recently, Royo and coworkers prepared the *O*,*O′*-diethyl-dithiophosphate derivative $Cp^*MoCl_2\{S_2P(OEt)_2\}$ by reduction of $Cp^*MoCl_3\{S_2P(OEt)_2\}$ [12].

The mono-indenyl analogues are still fewer. $IndMoCl_3$ was first cited in patent literature [13] and we recently reported its synthesis via decarbonylation of $IndMoCl_3(CO)_2$ according to the procedure discovered by Poli for $CpMoX_3$ [14].

In order to extend the scope of the chemistry of the (ring)Mo(IV) fragment, we decided to explore the synthesis of (ring)M(IV)L_n complexes directly from the available starting trihalides, (ring)$MoCl_3$ a method so far only used for some of the $CpMoX_3(PR_3)_2$ complexes mentioned above. In this work we report the synthesis of half-sandwich molybdenum(IV) complexes of the type (ring)$MoCl_2X$ [ring = cyclopentadie-

---

* Corresponding author. Tel.: +351-1-4418407; fax: +351-1-4411277

E-mail address: ccr@itqb.unl.pt (C.C. Romão).

0022-328X/02/$ - see front matter © 2002 Elsevier Science B.V. All rights reserved.
PII: S0022-328X(02)01701-1

nyl, η^5-C_5H_5 (Cp) or indenyl η^5-C_9H_7 (Ind) and X = S_2CNEt_2, $S_2P(OEt)_2$, $CH(NPh)_2$, O_2CCH_3 and acac].

2. Results and discussion

The reaction of (ring)$MoCl_3$ (ring = Cp and Ind) with the ammonium salt of the *O*,*O′*-diethyldithiophosphate $[S_2P(OEt)_2]^-$ anion affords the molybdenum(IV) dithiophosphate complexes (ring)$MoCl_2[S_2P(OEt)_2]$ [ring = Cp (**1**); Ind (**2**)] (see Scheme 1). Their IR spectra show a ν(PS) absorption at 640 and 644 cm^{-1} attributable to a chelated dithiophosphate ligand [12]. Similar reaction carried out using the silver salt of *N*,*N*-diethyldithiocarbamate ligand AgS_2CNEt_2 in dichloromethane affords the dithiocarbamate complexes (ring)$MoCl_2$-$[S_2CNEt_2]$ [ring = Cp (**3**); Ind (**4**)] (see Scheme 1). The IR spectra of both dithiocarbamate complexes **3** and **4** show a strong ν(CN) absorption at 1518 and 1512 cm^{-1} and a ν(CS) absorption at 1076 and 1075 cm^{-1}, respectively, attributable to a bidentate $[S_2CNEt_2]$ ligand [12].

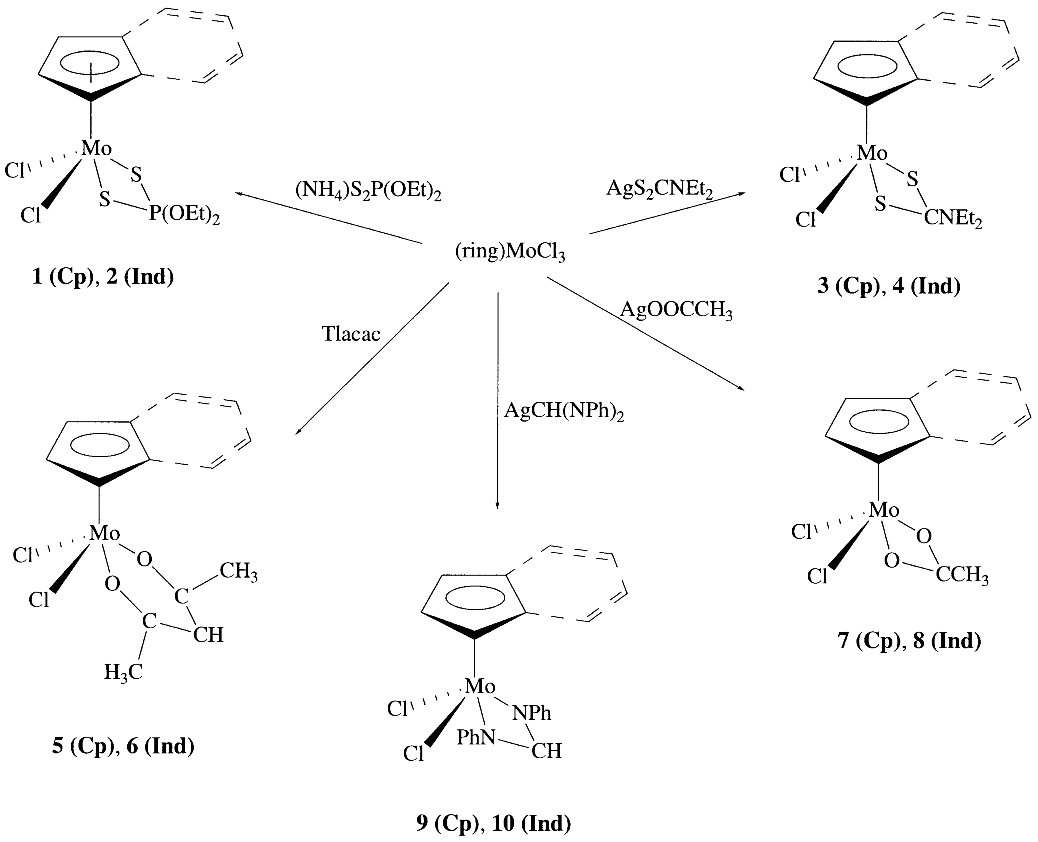
We have extended our studies to the synthesis of other molybdenum(IV) complexes with isoelectronic pseudo-allylic ligands containing nitrogen and oxygen atoms instead of sulphur. The reaction of (ring)$MoCl_3$ with one equivalent of thallium acetylacetonate or silver acetate in dichloromethane yields the corresponding (ring)$MoCl_2$(acac) [ring = Cp (**5**); Ind (**6**)] and (ring)Mo-$Cl_2(OOCCH_3)$ [ring = Cp (**7**); Ind (**8**)], respectively (see Scheme 1).

The formulation of complexes **1**–**8** as mononuclear 16 electron compounds is consistent with their spectral properties and magnetic behaviour. Thus, all these complexes are paramagnetic with magnetic values in accord with the spin-only value calculated for two unpaired electrons (2.83 μ_B). The paramagnetic behaviour for complexes **1**–**8** with values between 2.14 and 2.83 BM at 300 K is consistent with the spin triplet state expected for a pseudo-square pyramidal compound [15].

Magnetic moments for (ring)Mo(IV) compounds with this geometry have only been reported for the following 16 electron species: $Cp^*MoCl_3(PMe_3)$ [6] ($\mu_{eff} = 2.63\ \mu_B$) and $Cp^*MoCl_2[S_2P(OEt)_2]$ [12] ($\mu_{eff} = 2.75\ \mu_B$).

In the case of the dithiophosphate derivative **1**, the monomeric formulation has also been confirmed by MALDI-TOF mass spectrometry.

^{1}H-NMR was recorded for compounds **1**–**8**. Their spectra showed broad resonances, in the range between δ 1 and 8 ppm, with unresolved H–H coupling due to line broadening, except for the dithiocarbamates $CpMoCl_2[S_2CNEt_2]$ (**3**) and $IndMoCl_2[S_2CNEt_2]$ (**4**). The ^{1}H-NMR spectrum of **3** showed one signal for the cyclopentadienyl ring protons and two sets of signals for



Scheme 1.

non-equivalent ethyl groups, due to the different *endo* and *exo* orientations of the two ethyl groups. The ^{1}H-NMR spectrum of **4** showed three resonances for the indenyl ligand at δ 5.41, 5.61 and 7.18–7.31 and two sets of signals for non-equivalent ethyl groups.

The reaction of (ring)MoCl$_3$ with one equivalent of silver formamidinate AgCH(NPh)$_2$ in dichloromethane affords (ring)MoCl$_2$[CH(NPh)$_2$] [ring = Cp (**9**); Ind (**10**)]. In contrast to the other mononuclear (ring)Mo(IV) complexes described herein, the amidinato complexes **9** and **10** are diamagnetic, as evidenced by sharp, well resolved, ^{1}H-NMR spectra. This quite likely reflects the presence of a strong field ligand. A pseudo-square pyramidal molybdenum with a 16 electron configuration (a d^2 metal) can in principle be found in two different spin states: a diamagnetic state, where the two metal electrons are coupled in the d_{xy} orbital and the dz^2 orbital remains empty, or a triplet state, where the two metal frontier orbitals hold one electron each [16]. (ring)Mo(IV) complexes of the types I, II and III are usually paramagnetic with a triplet state (see Fig. 1). Exceptions have been reported in the literature when strong π-donor ligands are present. This is the case of Cp*MoHCl(PPh$_2$)(PMe$_3$) [8] which has a singlet ground state, certainly the result of the strong π-interaction of the phosphido ligand. Similar diamagnetic behaviour is observed for the tetrathiolato derivatives [CpMo-(SR)$_4$]$^-$ [17]. The isoelectronic Cp*ReCl$_3$Me derivative has been reported to exhibit spin-crossover behaviour [18]. The ^{1}H-NMR spectrum of the amidinato complex **10** was recorded at 90 °C showing unshifted resonances which indicates a singlet ground state. At higher temperature decomposition of the sample was observed.

The ^{1}H-NMR spectrum of **9** shows a singlet at δ 8.10 for the proton of the CH and a multiplet at δ 7.17–7.38 for the phenyl protons of the amidinato ligand. The cyclopentadienyl protons give a resonance at δ 5.23. Compound **10** gives a singlet at δ 8.35 for the proton of the CH and a multiplet at δ 7.07–7.48 for the phenyl protons of the amidinato ligand and a doublet at δ 5.59 (H$^{1/3}$), a triplet at δ 5.41 (H^2) and a multiplet at δ 6.88 (H$^{5-8}$) for the indenyl ligand (see Fig. 2).

All the complexes **1**–**10** are air-sensitive compounds. They can be stored as a solids under inert atmosphere for months but decomposition is observed if stored in solution. They are soluble in dichloromethane and insoluble in hexane, pentane, toluene and ether. Unfortunately, efforts to obtain single crystals for X-ray diffraction studies were unsuccesful.

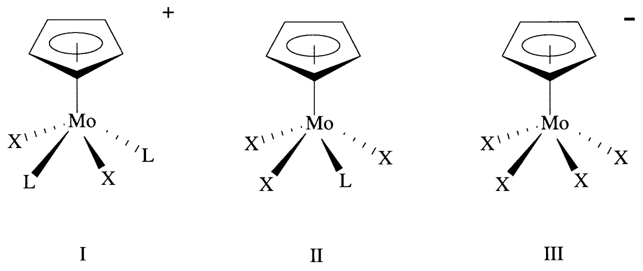


Fig. 1. Mo(IV) complexes of the type[(ring)MoX2L2]+(I), (ring)MoX3L(II) and [(ring)MoX4]−(III).

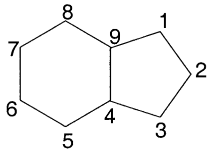


Fig. 2. Labelled carbon atoms of the indenyl ring.

3. Conclusion

The easily available (ring)MoCl$_3$ compounds can be used directly to prepare a number of derivatives in which one bidentate ligand replaces one chloride forming pentacoordinate complexes of general formula (ring)MoCl$_2$X (X = bidentate anionic N$_2$, O$_2$, S$_2$ donors). With the exception of the formamidinate derivatives all complexes are paramagnetic with two unpaired electrons.

4. Experimental

4.1. Materials and procedures

All operations were carried out under an atmosphere of dinitrogen with standar Schlenk-line and glove-box techniques. Solvents were purified by conventional methods and distilled under nitrogen prior to use. NMR spectra were measured on a Bruker CXP 300 spectrometer, and IR spectra were measured on a Unicam Mattson model 7000 FTIR spectrometer. Elemental analyses were performed in our laboratories (ITQB). Magnetic moments have been determined at room temperature (r.t.) with a Johnson–Matthey magnetic susceptibility balance and were corrected for diamagnetic contributions of the ligands by using Pascal's constants before conversion to magnetic moments. MALDI mass measurements were performed on a Reflex time-of-flight instrument (Bruker-Franzen Analytik, Bremen, Germany) equipped with a SCOUT ion source, operating in the positive reflection mode with pulsed extraction. Ions were formed by a pulsed UV laser beam (nitrogen laser, $\lambda = 337$ nm). No matrix was required for the ionization of the sample. External mass calibration was made by using the [M + H]$^+$ ion of α-cyano-4-hydroxycinnamic and angiotensin II.

All common chemicals and solventes were purchased from commercial suppliers. The synthesis of *N*,*N'*-diphenylformamidinato [19], CpMoCl$_3$ [5] and Ind$MoCl_3$ [14] was prepared according to literature procedure. Thallium acetylacetonate was prepared by reaction of acetylacetone with thallium ethoxide in toluene at r.t.

4.2. Preparation of *$CpMoCl_2[S_2P(OEt)_2]$ (**1**)*

Solid ammonium diethyldithiophosphate (0.21 g, 1.04 mmol) was added to a suspension of $CpMoCl_3$ (0.28 g, 1.04 mmol) in 40 ml of CH_2Cl_2 at r.t. The purple-brown color of the suspension changed to give a brown suspension after stirring for 10 h. The reaction mixture was filtered and the filtrate was concentrated to dryness. The solid residue was washed with Et_2O (3 × 5 ml). Compound **1** was isolated as a brown solid. Yield: 0.35 g (82%). Selected IR (KBr, cm^{-1}): 1006, vs, 960, vs $\nu(POC)_{asym}$, 812, vs, 792, vs $\nu(POC)_{sym}$, 640, vs, $\nu(PS)$. Anal. Calc. for $C_9H_{15}Cl_2MoO_2PS_2$: C, 25.91; H, 3.62. Found: C, 26.02; H, 3.52%. $\mu_{eff} = 2.45\ \mu_B$. MS: 418 [M^+].

4.3. Preparation of *$IndMoCl_2[S_2P(OEt)_2]$ (**2**)*

Solid ammonium diethyldithiophosphate (0.19 g. 0.94 mmol) was added to a stirred suspension of $IndMoCl_3$ (0.3 g, 0.94 mmol) in 30 ml of CH_2Cl_2 at r.t. The reaction was completed after 10 h stirring leading a brown solution. The solution was filtered and the filtrate was concentrated to dryness to give **2** as a brown solid, which was washed with Et_2O (3 × 5 ml). Yield: 0.35 g (80%). Selected IR (KBr, cm^{-1}): 1008, vs, 956, vs, $\nu(POC)_{asym}$, 758, vs, $\nu(POC)_{sym}$, 644, vs $\nu(PS)$. Anal. Calc. for $C_{13}H_{17}Cl_2MoO_2PS_2$: C, 33.42; H, 3.67. Found: C, 33.26; H, 3.58%. $\mu_{eff} = 2.77\ \mu_B$.

4.4. Preparation of *$CpMoCl_2(S_2CNEt_2)$ (**3**)*

Solid silver diethyldithiocarbamate (0.28 g, 1.12 mmol) was added to a stirred suspension of $CpMoCl_3$ (0.3 g, 1.12 mmol) in 40 ml of CH_2Cl_2 at r.t. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness to yield the title compound **3** as a brown solid, which was washed with Et_2O (3 × 5 ml). Yield: 0.36 g (86%). Selected IR (KBr, cm^{-1}): 1518, vs, $\nu(CN)_{asym}$, 1076, vs, $\nu(CS)$. Anal. Calc. for $C_{10}H_{15}Cl_2MoNS_2$: C, 31.59; H, 3.98; N 3.68. Found: C, 31.59; H, 3.83; N, 3.73%. ^1H-NMR (C_6D_6, 25 °C, δ ppm): 4.89 (s, Cp); 3.10 (br m, ethyl); 0.66 (br m, ethyl), 0.78 (br m, ethyl). $\mu_{eff} = 2.14\ \mu_B$.

4.5. Preparation of *$IndMoCl_2(S_2CNEt_2)$ (**4**)*

Solid silver dithiocarbamate (0.24 g, 0.94 mmol) was added to a stirred suspension of $IndMoCl_3$ (0.3 g, 0.94 mmol) in 40 ml of CH_2Cl_2 at r.t. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness to yield the title compound **4** as a brown solid which was washed with Et_2O (3 × 5 ml). Yield: 0.34 g (85%). Selected IR (KBr, cm^{-1}) 1512, vs, $\nu(CN)_{asym}$, 1075, vs, $\nu(CS)$. Anal. Calc. for $C_{14}H_{17}Cl_2MoNS_2$: C, 39.08; H, 3.98; N, 3.26. Found: C, 39.02; H, 3.83; N, 2.97%. ^1H-NMR (C_6D_6, 25 °C, δ ppm): 7.18–7.31 (m, H^{5-8}); 5.61 (d, $H^{1/3}$); 5.41 (t, 1H, H^2); 3.93 (br m, ethyl); 1.55 (br m, ethyl), 1.26 (br m, ethyl). $\mu_{eff} = 2.63\ \mu_B$.

4.6. Preparation of *$CpMoCl_2(acac)$ (**5**)*

To a suspension of $CpMoCl_3$ (0.3 g, 1.12 mmol) in 50 ml of CH_2Cl_2 was added Tl(acac) as a solid (0.34 g, 1.12 mmol) at r.t. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness and the residue was washed with Et_2O (3 × 5 ml) to yield the title compound **5** as a brown solid. Yield: 0.28 g (76%). Selected IR (KBr, cm^{-1}): 1521, vs, $\nu(CO)$. Anal. Calc. for $C_{10}H_{12}Cl_2MoO_2$: C, 36.28; H, 3.65. Found: C, 36.10; H, 3.72%. $\mu_{eff} = 2.21\ \mu_B$.

4.7. Preparation of *$IndMoCl_2(acac)$ (**6**)*

To a suspension of $IndMoCl_3$ (0.20 g, 0.66 mmol) in 40 ml of CH_2Cl_2 was added Tl(acac) as a solid (0.20 g, 0.66 mmol) at r.t. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness and the residue was washed with Et_2O (3 × 5 ml) to yield the title compound **6** as a brown solid. Yield: 0.18 g (72%). Selected IR (KBr, cm^{-1}): 1523, vs, $\nu(CO)$. Anal. Calc. for $C_{14}H_{14}Cl_2MoO_2$: C, 44.12; H, 3.70. Found: C, 43.91; H, 4.01%. $\mu_{eff} = 2.58\ \mu_B$.

4.8. Preparation of *$CpMoCl_2(OOCMe)$ (**7**)*

To a stirred suspension of $CpMoCl_3$ (0.3 g, 1.12 mmol) in 40 ml of CH_2Cl_2 was added AgOOCMe as a solid (0.18 g, 1.12 mmol) at r.t. The reaction was complete after 6 h stirring leading to a red–brown solution. The AgCl precipitate was filtered and the solvent was removed from the filtrate under vacuum to give a brown residue which after being washed with Et_2O (3 × 5 ml) yield the title compound **7** as a brown solid. Yield: 0.28 g (87%). Selected IR (KBr, cm^{-1}) 1548, vs, $\nu(CO)$. Anal. Calc. for $C_7H_8Cl_2MoO_2$: C, 28.89; H, 2.77. Found: C, 28.86; H, 3.02%. $\mu_{eff} = 2.62\ \mu_B$.

4.9. Preparation of *$IndMoCl_2$ (OOCMe) (**8**)*

To a stirred suspension of $IndMoCl_3$ (0.17 g, 0.53 mmol) in 20 ml of CH_2Cl_2 was added AgOOCMe as a solid (0.09 g, 0.53 mmol) at r.t. The reaction mixture was stirred for 6 h and the solution was filtered. The filtrate was taken to dryness and the residue was washed with Et_2O (3 × 5 ml) to yield the title compound **8** as a brown solid. Yield: 0.16 g (80%). Selected IR (KBr, cm^{-1}): 1537, vs, ν(CO). Anal. Calc. for $C_9H_{12}Cl_2MoO_2$: C, 38.74; H, 2.96. Found: C, 38.46; H, 2.68%. $\mu_{eff} = 2.84$ μ_B.

4.10. Preparation of $CpMoCl_2[CH(NPh)_2]$ (**9**)

Solid $AgCH(NPh)_2$ (0.49 g, 1.64 mmol) was added to a stirred suspension of $CpMoCl_3$ (0.44 g, 1.64 mmol) in 50 ml of CH_2Cl_2. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness and the residue was washed with Et_2O (3 × 5 ml) to yield the title compound **9** as a brown solid. Yield: 0.55 g (78%). Selected IR (KBr, cm^{-1}): 1689, vs, $\nu(NCN)_{asym}$, 1589, vs, 1531, vs, ν(CN). Anal. Calc. for $C_{18}H_{16}Cl_2MoN_2$: C, 50.61; H, 3.78; N, 6.56. Found: C, 50.57; H, 3.56; N, 6.43%. ^{1}H-NMR (CD_2Cl_2, 25 °C, δ ppm): 8.10 (s, 1H); 7.17–7.38 (m, 10H); 5.23 (s, 5H).

4.11. Preparation of $IndMoCl_2[CH(NPh)_2]$ (**10**)

Solid $AgCH(NPh)_2$ (0.28 g, 0.94 mmol) was added to a stirred suspension of $IndMoCl_3$ (0.3 g, 0.94 mmol) in 50 ml of CH_2Cl_2. The reaction mixture was stirred for 10 h and the solution was filtered. The filtrate was taken to dryness and the residue was washed with Et_2O (3 × 5 ml) to yield the title compound **10** as a brown solid. Yield: 0.36 g (82%). Selected IR (KBr, cm^{-1}): 1680, vs, $\nu(NCN)_{asym}$, 1564, vs, ν(CN). Anal. Calc. for $C_{22}H_{18}Cl_2MoN_2$: C, 55.37; H, 3.80; N, 5.87. Found: C, 55.57; H, 3.98; N, 5.96%. ^{1}H-NMR (CD_2Cl_2, 25 °C, δ ppm): 8.35 (s, 1H); 7.07–7.48 (m, 10H); 6.88 (m, 4H, H^{5-8}); 5.59 (d, 2H, $H^{1/3}$); 5.41 (t, 1H, H^2).

Acknowledgements

This work was supported by PRAXIS XXI under project 2/2.1/QUI/316/94. B.R. thanks PRAXIS XXI for a postdoctoral grant.

References

[1] (a) R.J. Haines, R.S. Nyholm, M.H.B. Stiddard, J. Chem. Soc. Sect. A (1966) 1606;
(b) M.L.H. Green, W.E. Lindsell, J. Chem. Soc. Sect. A (1967) 686;
(c) J.C.T.R. Burckett-St. Laurent, J.S. Fields, R.J. Haines, M. McMahon, J. Organomet. Chem. 181 (1979) 117.
[2] J.A. Dineen, P.L. Pauson, J. Organomet. Chem. 71 (1974) 91.
[3] T. Aviles, M.L.H. Green, A.R. Dias, C. Romão, J. Chem. Soc. Dalton Trans. (1979) 1367.
[4] F. Abugideiri, J.C. Fettinger, B. Pleune, R. Poli, C.A. Bayse, M.B. Hall, Organometallics 16 (1997) 1179.
[5] J.C. Gordon, V.T. Lee, R. Poli, Inorg. Chem. 32 (1993) 4460.
[6] F. Abugideiri, G.A. Brewer, J.U. Desai, J.C. Gordon, R. Poli, Inorg. Chem. 33 (1994) 3745.
[7] R. Poli, M.A. Kelland, J. Organomet. Chem. 419 (1991) 127.
[8] R.T. Baker, J.C. Calabrese, R.L. Harlow, I.D. Williams, Organometallics 12 (1993) 830.
[9] M. Kilner, C. Midcalf, J. Chem. Soc. Sect. A (1971) 292.
[10] (a) J. Locke, J.A. McCleverty, Inorg. Chem. 5 (1966) 1157;
(b) M.R. Churchill, J. Cooke, J. Chem. Soc. Sect. A (1970) 2046.
[11] J.L. Davidson, W.E. Lindsell, K.J. McCullough, C.H. McIntosh, Organometallics 14 (1995) 3497.
[12] M.V. Galakhov, P. Gómez-Sal, T. Pedraz, M.A. Pellinghelli, P. Royo, A. Tiripicchio, A. V'zquez de Miguel, J. Organomet. Chem. 579 (1999) 190.
[13] R.D. Gorsich, U.S. Patent 3,080,305, Mar 5, 1063 Chem. Abstr., 59 (1963) 3957c.
[14] M.G.B. Drew, V. Félix, I.S. Gonçalves, C.C. Romão, B. Royo, Organometallics 17 (1998) 5782.
[15] (a) R. Poli, Chem. Rev. 96 (1996) 2135;
(b) R. Poli, B.E. Owens, S.T. Krueger, A.L. Rheingold, Polyhedron 1 (1992) 2301;
(c) F. Abugideiri, J.C. Gordon, R. Poli, B.E. Owens-Waltermire, A.L. Rheingold, Organometallics 12 (1993) 1575.
[16] (a) P. Kubácek, R. Hoffmann, Z. Havlas, Organometallics 1 (1982) 180;
(b) R. Poli, Organometallics 9 (1990) 1892.
[17] (a) W.A.W. Abu Bakar, J.L. Davidson, W.E. Lindsell, K.J. McCullogh, J. Chem. Soc. Dalton Trans. (1990) 61;
(b) W.A.W. Abu Bakar, J.L. Davidson, W.E. Lindsell, K.J. McCullogh, K.W. Muir, J. Chem. Soc. Dalton Trans. (1989) 991.
[18] W.A. Herrmann, J.K. Felixberger, E. Herdtweck, A. Schäfer, J. Okuda, Angew. Chem. 99 (1987) 466.
[19] R.M. Roberts, J. Org. Chem. 14 (1949) 277.