

The platinum catalyzed selective hydration of hindered nitriles and nitriles with acid or base sensitive groups

Xiao-bin Jiang,^a Adriaan J. Minnaard,^{a*} Ben L. Feringa,^{a*} and Johannes G. de Vries^{a, b*}

- a. Department of Organic and Molecular Inorganic Chemistry, Stratingh Institute, University of Groningen, Nijenborgh 4, 9747AG Groningen, The Netherlands.
- b. DSM Pharma Chemicals, Advanced Synthesis & Catalysis, P. O. Box 18, 6160 MD Geleen, The Netherlands.

Hans-JG.Vries-de@dsm.com

Supporting information

Table of contents

1. General methods	s2
2. The synthetic procedure for nitrile 4d , 4e	s2-3
3. Copies of ¹ H, ¹³ C, Mass, 2D COSY, NOESY spectrum of amide 5j	s4-7
4. Copies of ¹ H, ¹³ C spectrum of amide 5a-c	s8-10
5. Selected X-ray data of catalyst 2	s11-13

1. General methods

^1H NMR (300 MHz, 500 MHz) and ^{13}C NMR (121 MHz) spectra were recorded in CDCl_3 , DMSO-d_6 or D_2O . Chemical shifts were recorded in δ units (ppm) relative to the residue deuterated solvent signals of CHCl_3 (^1H : 7.25 ppm, ^{13}C : 77.7 ppm); DMSO-d_6 (^1H : 2.5 ppm, ^{13}C : 39.5 ppm); D_2O (^1H : 4.72 ppm). Coupling constant was recorded by Hertz (Hz). All melting points were taken with a capillary melting point apparatus and were not corrected. Optical rotations were measured on a polarimeter at ambient temperature. Mass spectra were measured on a mass spectrometer using electron impact ionization (EI, 70 eV), chemical ionization (CI) and electro spray. All solvents were analytic grade and were purified according to standard procedures, if necessary. Gas chromatographic analyses were performed on an HP-1 crosslinked methyl silicone capillary column (25 m length x 0.2 mm i.d.) and an FID detector using He as carrier gas. Enantiomeric pure ligands **L1** were separated by preparative HPLC (Daicel, chiralpak AD, Preparative 250 x 20 mm i.d., heptane / 2-propanol 90 / 10, flow 20 ml / min, detecting wave length 254nm). PtCl_2 was purchased from Strem chemical Inc. and used directly without any further purification. Nitriles **4a-c**, **4f-k** were purchased from Acros chemicals Inc. and used as received unless stated otherwise. Nitriles **4d**, **4e** were prepared using modify of reported procedure.¹

2. The synthetic procedure for nitrile **4d**, **4e**

2-Methyl-2-phenylpentanenitrile (4d)¹ A solution of diisopropyl amine (55 mmol, 7.7 ml) in 30 ml of dry THF was cooled to 0 °C and a solution of n-BuLi (1.6 M in hexane, 35 ml, 56 mmol) was added slowly and the mixture kept at 0 °C for 1 h. Hereafter nitrile **4k** (50 mmol, 6.7 ml) in 10 ml of dry THF was added dropwise, followed after 30 min at 0 °C by a solution of allyl bromide (51 mmol, 4.4 ml) in 10 ml THF. The reaction mixture was allowed to warm to RT overnight, diluted with 30 ml of H_2O , extracted with Et_2O , washed with

¹ Woods, G. F.; Heying, T. L.; Schwartzman, L. H.; Grenell, S. M.; Gasser, W. F.; Rowe, E. W.; Bolgiano, N. C. *J. Org. Chem.*

brine and dried over MgSO_4 . After removal of the solvent a slightly yellow oil was obtained. The crude product was directly hydrogenated with 10% Pd/C and H_2 (balloon) in 30 ml absolute EtOH, during 24 h at RT. The reaction mixture was filtered and washed with EtOH. After removal of the solvent, yellow-brown oil remained, which was purified by vacuum distillation $70\text{ }^\circ\text{C}/0.14\text{ Torr}$ (lit.¹ $135\text{-}145\text{ }^\circ\text{C}/2.3\text{ Torr}$). The product was isolated as colorless oil in 86% yield.

^1H (CDCl_3) δ 0.85 (t, $J=7.0\text{Hz}$, 3H), 1.14-1.26 (m, 1H), 1.38-1.52 (m, 1H), 1.66 (s, 3H), 1.75-1.89 (m, 2H), 7.21-7.40 (m, 5H); ^{13}C (CDCl_3) δ 138.9, 127.3, 126.1, 123.9, 122.1, 42.8, 41.0, 26.2, 17.4, 12.4; HRMS (EI^+) m/z 173.1202, calcd for $\text{C}_{12}\text{H}_{15}\text{N}$ 173.1204.

2-Methyl-2,3-diphenylpropanenitrile (4e)² was prepared from nitrile **4k** and benzyl bromide using a similar procedure as for **4d**, purified by SiO_2 column, Petroleum Ether/ Et_2O 2/1 to get a yellow oil, isolated yield 98%.

^1H (CDCl_3) δ 1.79 (s, 3H), 3.19 (s, 2H), 7.10-7.15 (m, 2H), 7.28-7.40 (m, 3H), 7.41-7.49 (m, 5H); ^{13}C (CDCl_3) δ 138.3, 133.7, 128.9, 127.4, 126.7, 126.5, 125.9, 124.5, 121.7, 47.0, 42.1, 24.6; HRMS (EI^+) m/z 221.1214, calcd for $\text{C}_{16}\text{H}_{15}\text{N}$ 221.1204.

3. Copies of ^1H , ^{13}C , Mass, 2D COSY, NOSY spectrum of amide **5j**

1954, 19, 1290-1295.

² (a) Takeda, T.; Ando, K.; Mamada, A.; Fujiwara, T. *Chem. Lett.* **1985**, 1149-1152. (b) Ronald, G.; Mitchell, T. R. B.; Somyote, S.; Ngampong, T. *Tetrahedron Lett.* **1981**, 22, 4107-4110. (c) Bordwell, F. G.; Hughes, D. L. *J. Org. Chem.* **1983**, 48, 2206-2215. (d) Makoza, M.; Stalinski, K. *Tetrahedron* **1998**, 54, 8797-8810.

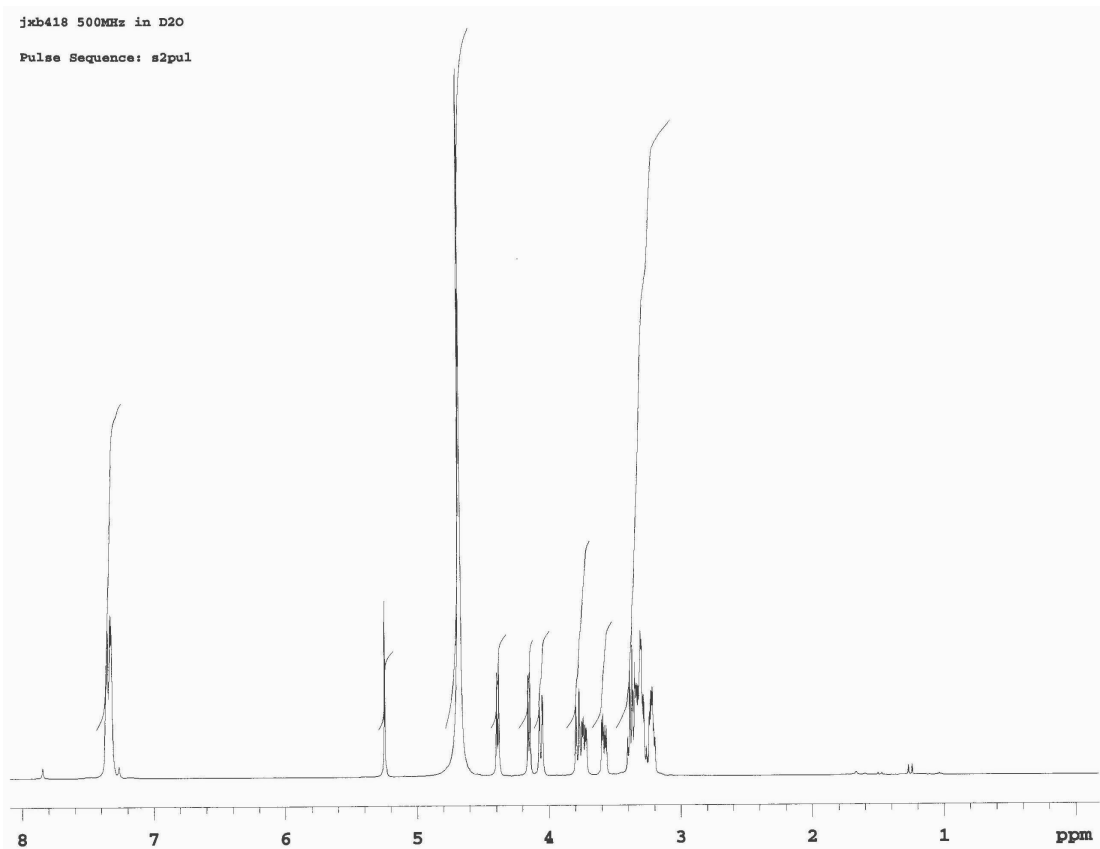


Figure 1 Copy of ^1H NMR (D_2O , 500MHz) of amide **5j**

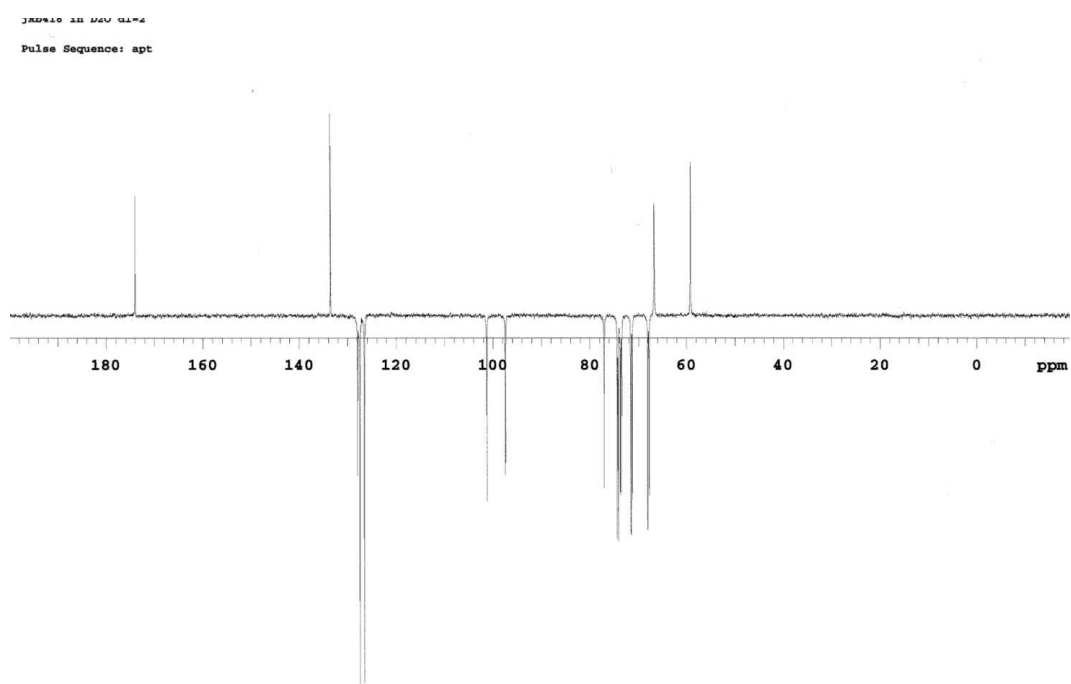


Figure 2 Copy of ^{13}C NMR (D_2O) of amide **5j**

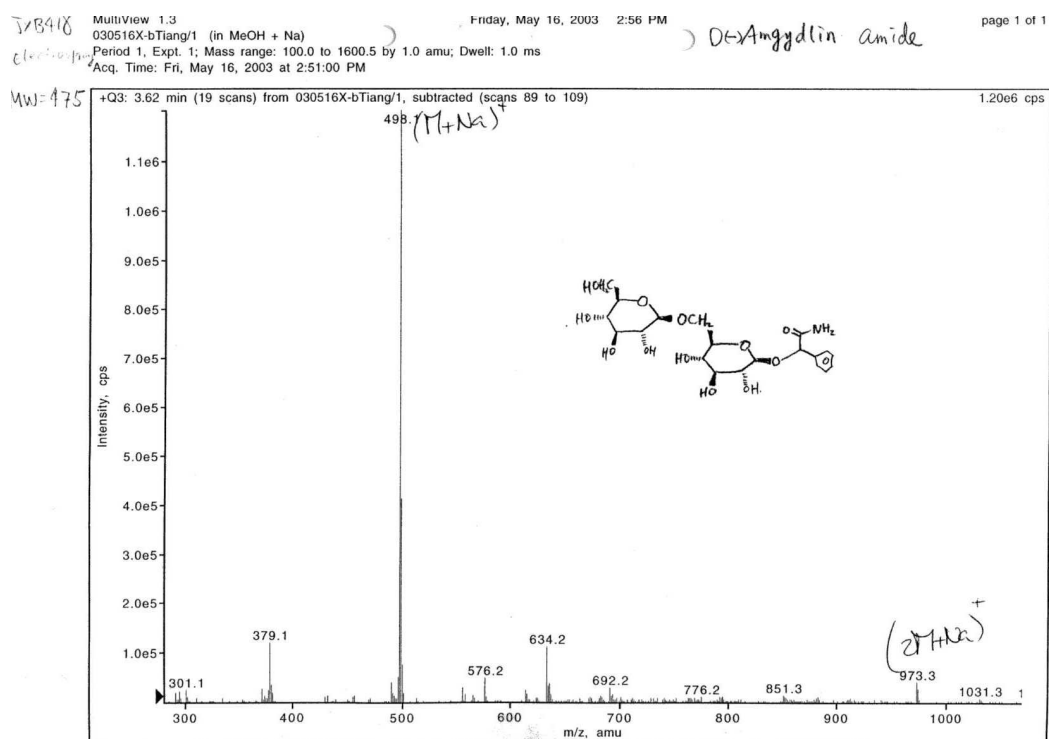


Figure 3 Copy of Mass spectrum (electro spray) of amide **5j**

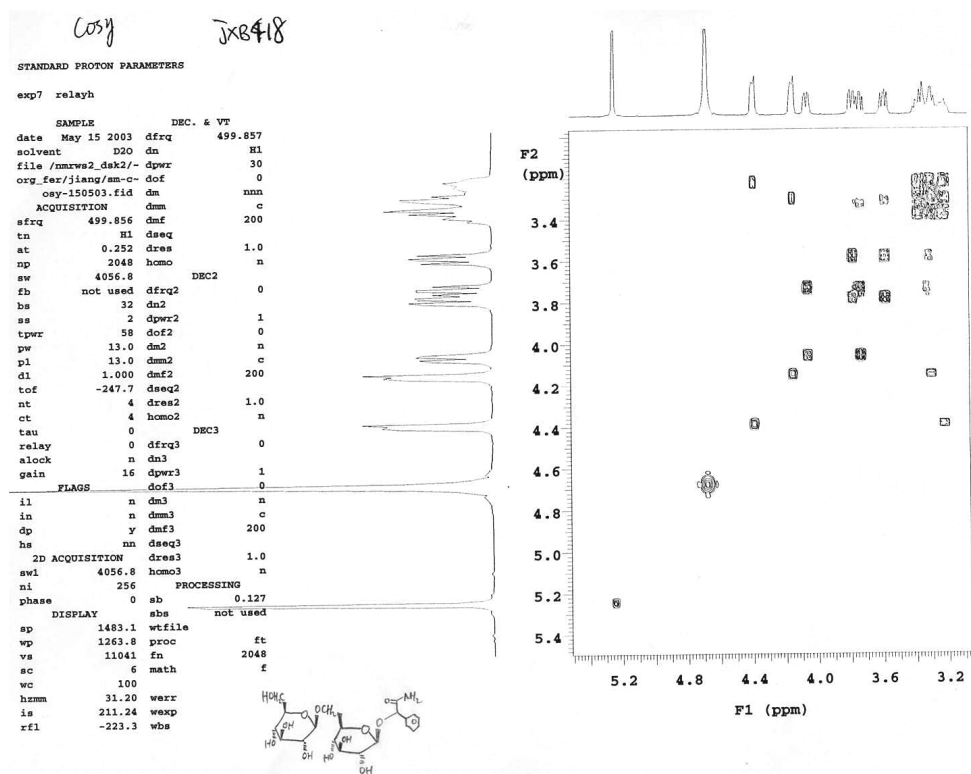


Figure 4 Copy of COSY (D₂O, 500MHz) NMR of amide 5j

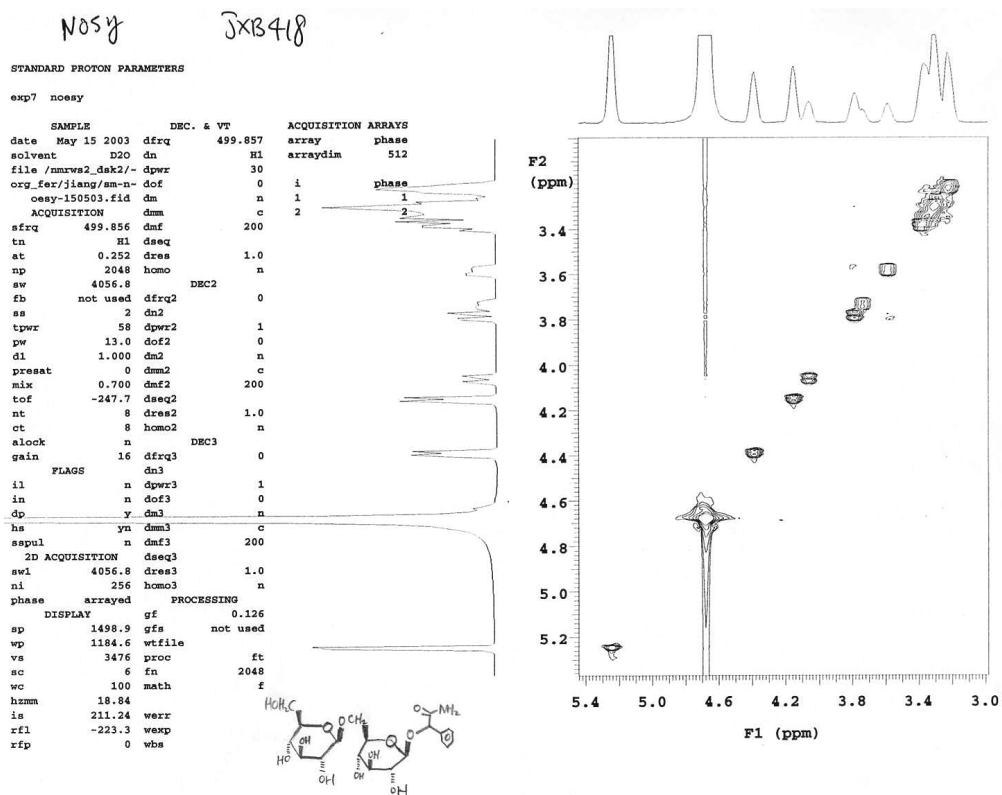


Figure 5 Copy of NOESY (D₂O, 500MHz) NMR of amide **5j**

4. Copy of ¹H, ¹³C NMR of amides **5a-c**

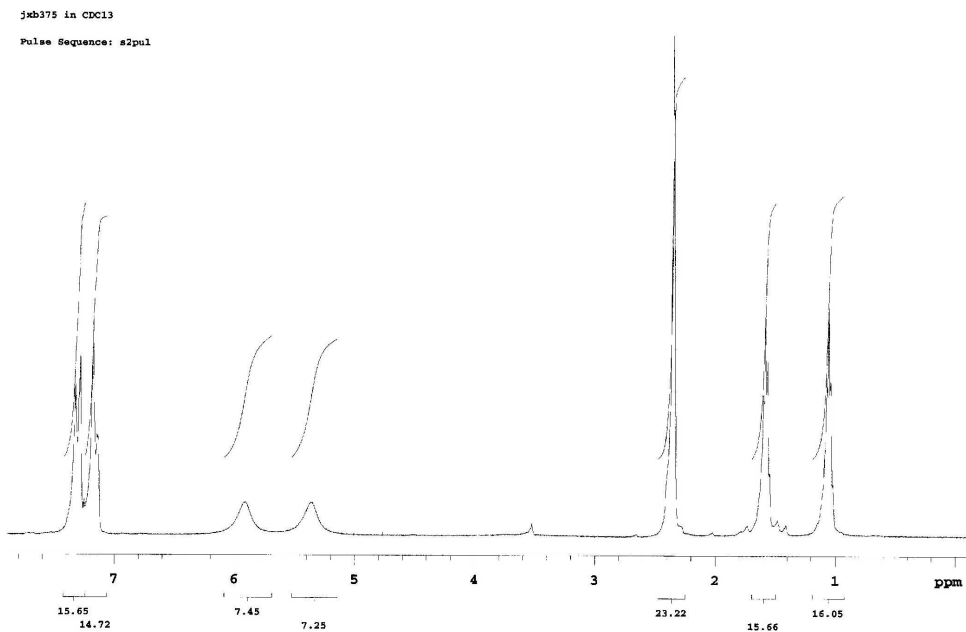


Figure 6 Copy of ¹H NMR (CDCl₃) of amide **5a**

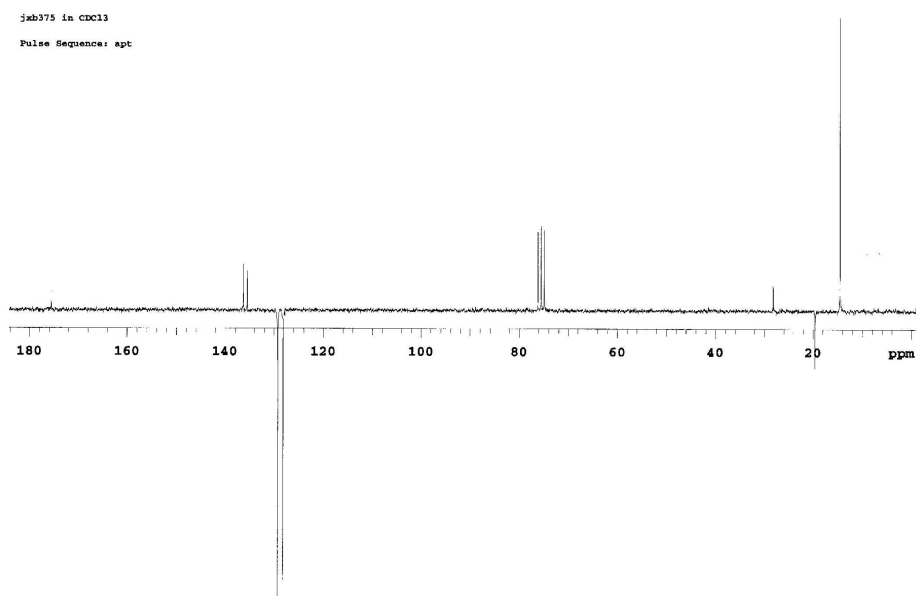


Figure 7 Copy of ¹³C NMR (CDCl₃) of amide **5a**

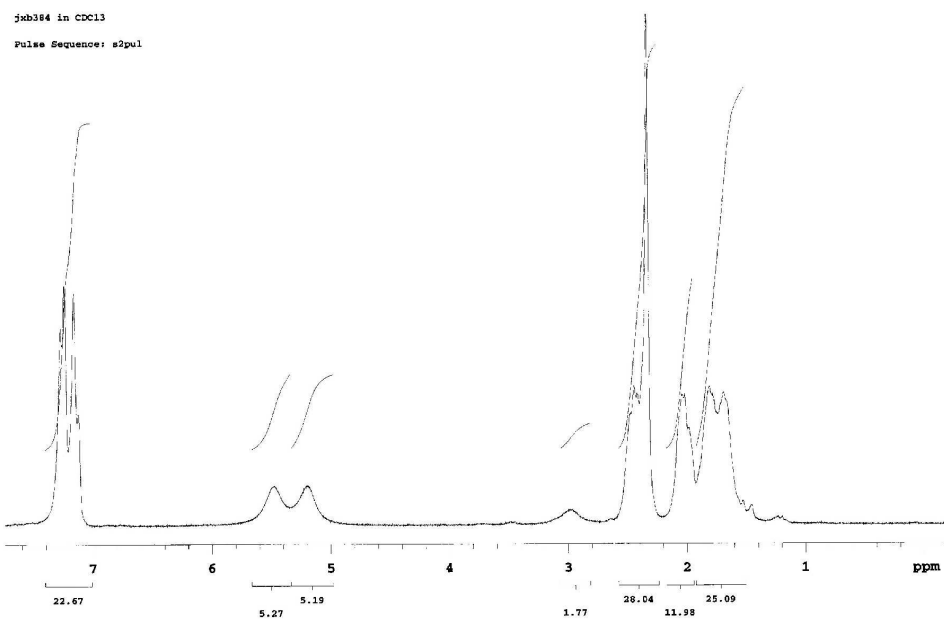


Figure 8 Copy of ^1H NMR (CDCl_3) of amide **5b**

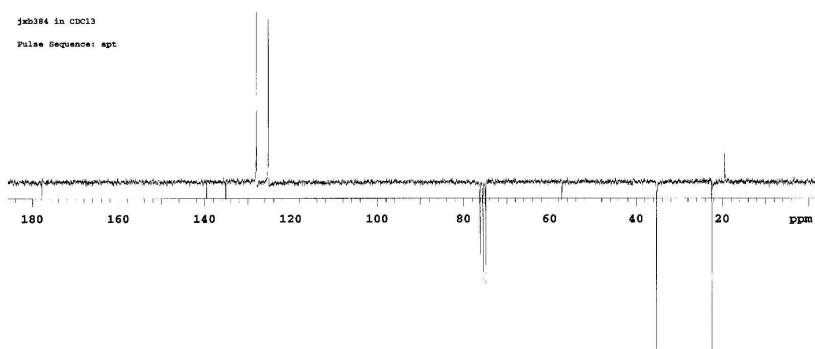


Figure 9 Copy of ^{13}C NMR (CDCl_3) of amide **5b**

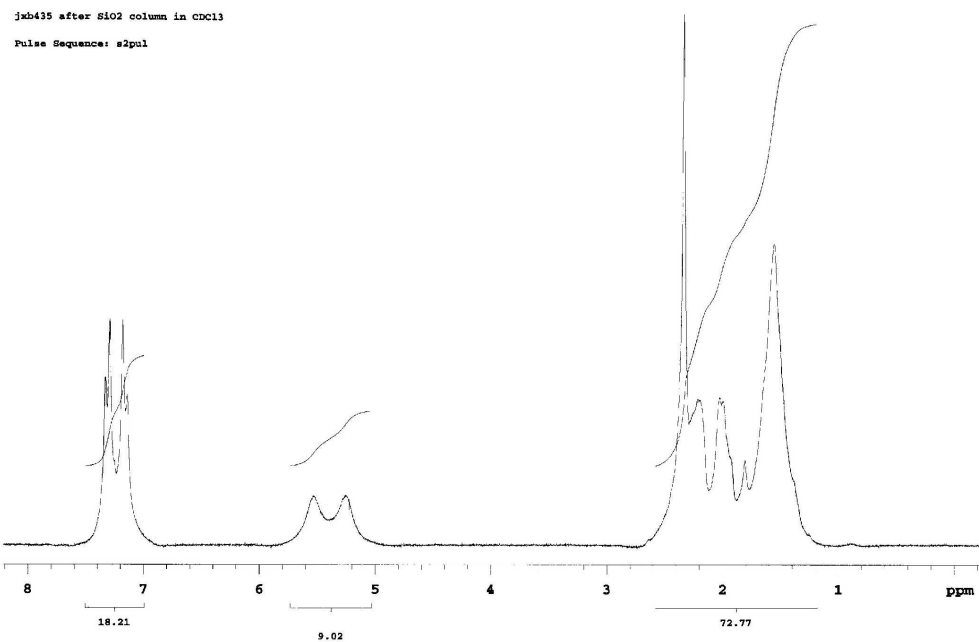


Figure 10 Copy of ^1H NMR (CDCl_3) of amide **5c**

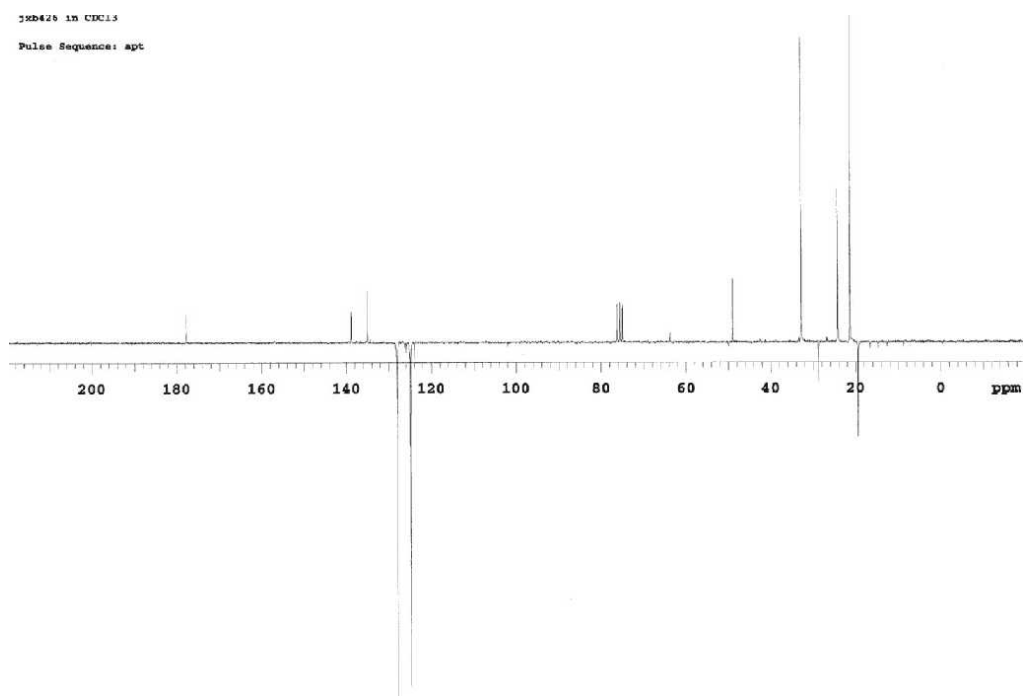


Figure 12 Copy of ^{13}C NMR (CDCl_3) of amide **5c**

5. Selected X-ray data of catalyst 2

Crystallographic data: colorless needle-shaped crystals, $\text{C}_6\text{H}_{20}\text{ClO}_3\text{P}_3\text{Pt} \cdot 0.5(\text{H}_2\text{O})$; orthorhombic, $Fdd2$, cell constants $a = 30.408(2)$, $b = 32.819(2)$, $c = 6.0421(4) \text{ \AA}$, $V = 6029.8(7) \text{ \AA}^3$, $Z = 16$, $D_x = 2.087 \text{ g cm}^{-3}$, $F(000) = 3616$, $\mu = 97.93 \text{ cm}^{-1}$, $\lambda(\text{MoK}\alpha) = 0.71073 \text{ \AA}$; temperature of data collection 293K, 14333 reflections measured, $\text{GOF} = 0.921$, $wR(F^2) = 0.0368$ for 3994 reflections and 137 parameters, 1 restraints and $R(F) = 0.0200$ for 3680 reflections obeying $F_o \geq 4.0 \sigma(F_o)$ criterion of observability.

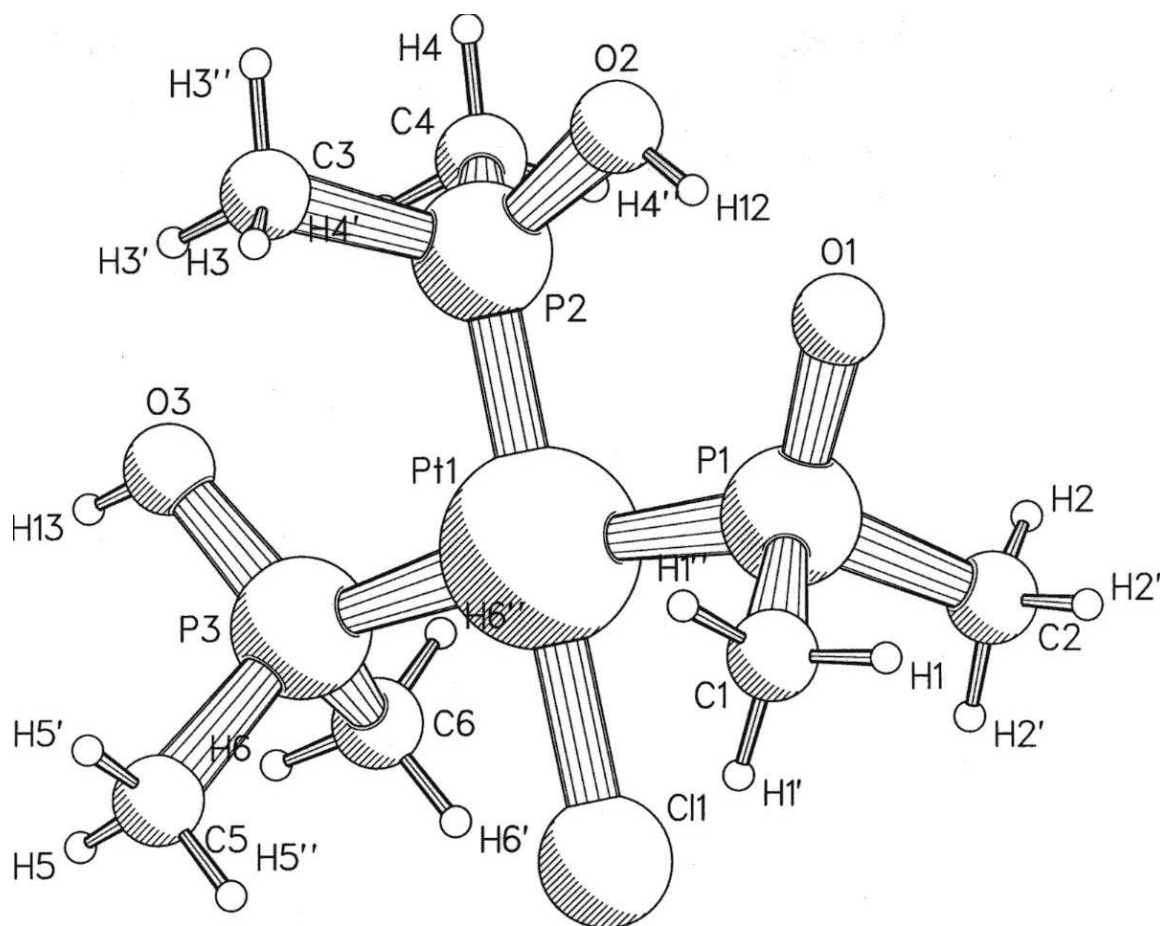


Figure 13 Perspective PLUTO drawing of catalyst 2

Table 1 Interatomic distance (Å)

Pt1	Cl1	2.2814(10)
Pt1	P1	2.3164(10)
Pt1	P2	2.2259(10)
Pt1	P3	2.3291(10)
P1	O1	1.554(3)
P1	C1	1.796(5)
P1	C2	1.797(4)
P2	O2	1.573(3)
P2	C3	1.797(5)
P2	C4	1.797(5)
P3	O3	1.590(4)
P3	C5	1.798(5)
P3	C6	1.790(5)

Standard deviations in the last decimal place are given in parentheses.

Table 2 Bond angles (°)

Cl1	Pt1	P1	85.89(4)
Cl1	Pt1	P2	178.98(4)
Cl1	Pt1	P3	85.06(4)
P1	Pt1	P2	94.09(4)
P1	Pt1	P3	170.93(4)
P2	Pt1	P3	94.95(5)
Pt1	P1	O1	117.80(12)
Pt1	P1	C1	111.08(15)
Pt1	P1	C2	112.20(14)
O1	P1	C1	105.99(19)
O1	P1	C2	105.4(2)
C1	P1	C2	103.2(2)
Pt1	P2	O2	116.07(12)
Pt1	P2	C3	113.83(17)
Pt1	P2	C4	113.07(16)
O2	P2	C3	103.6(2)
O2	P2	C4	104.20(19)
C3	P2	C4	104.9(2)
Pt1	P3	O3	115.89(13)
Pt1	P3	C5	113.49(16)
Pt1	P3	C6	111.74(16)
O3	P3	C5	104.7(2)
O3	P3	C6	106.0(2)
C5	P3	C6	104.0(3)

Standard deviations in the last decimal place are given in parentheses.

Table 3 Geometry of intra- and intermolecular hydrogen bonds (Å, °) with *s.u.*'s in parentheses

D-H...A	[ARU-code]	D-H (Å)	H...A (Å)	D...A (Å)	D-H...A (°)
O2-H12...O1	[]	0.82	1.63	2.446(4)	178
O3-H13...O1	[8455.01]	0.82	1.78	2.593(4)	169

Note: ARU codes in [] are with reference to the Coordinates printed above

Translation of ARU-code to Equivalent Position Code: [8455.] = -1/4+x,-1/40-y,3/4+z