Specialised Olefin Metathesis Catalysts Featuring Unsymmetrical N-Heterocyclic Carbene Ligands Bearing N-(fluoren-9-yl) Arm

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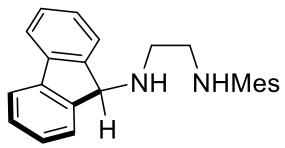
Supporting Information

General remarks

All reagents were purchased from Sigma-Aldrich, Apeiron, Strem, TCI, and Alfa Aesar and used without further purification unless stated otherwise. Reactions which required use of moisture and oxygen-free conditions were performed using Schlenk technique or in the glovebox, under atmosphere of argon with use of dry and degassed solvents from SPS (Solvent Purification System). The stock solutions of catalyst were prepared in the glovebox under moisture and oxygen-free conditions. Analytical thin-layer chromatography (TLC) was performed using silica gel 60 F254 precoated plates (0.25 mm thickness) with a fluorescent indicator. Visualization of TLC plates was performed by UV light or by $KMnO_4$ water solution. Flash chromatography was performed using silica gel 60 (230–400 mesh). GC analysis were done using Clarus 580 chromatograph using tetradecane as an internal standard. ^1H and ^{13}C NMR spectra were recorded on an Agilent 400-MR DD2 400 MHz spectrometer. Chemical shifts (δ) are given in ppm with coupling constants (J) in Hz, they are reported relative to reference solvent peaks in deuterated solvent: 7.26 and 77.16 ppm for ^1H and ^{13}C NMR respectively in $CDCl_3$; 5.32 and 53.84 ppm for ^1H and ^{13}C NMR respectively in CD_2Cl_2. The following abbreviations are used to denote multiplicity: s-singlet, d-doublet, t-triplet, q-quartet, m-multiplet, dd-doublet of doublets, dt- doublet of triplets, ddd- doublet of doublets of doublets. IR spectra were recorded on JASCO FT/IR-6200 spectrometer. Wavenumbers are given in cm^{-1}. High resolution electrospray mass spectroscopy (ESI-HRMS) were obtained on AutoSpec Premier spectrometer. Melting points were recorded on an OptiMelt SRS apparatus with a heating rate of 10 °C/min.

Preparation of 2-(pentafluorophenyl)imidazolidines

Synthesis of *N*¹-(9H-fluoren-9-yl)-*N*²-mesitylethane-1,2-diamine (5)



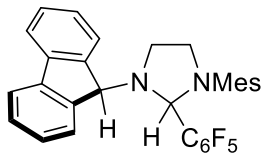
9-Fluorenone (2.92 g, 16.0 mmol, 1.0 equiv.) was dissolved in the minimum volume of methanol with vigorous stirring. After 45 minutes titanium(IV) *iso*-propoxide (4.84 mL, 16.0 mmol, 1.0 equiv.) was added followed by *N*¹-mesitylethane-1,2-diamine (4.00 g, 22.4 mmol, 1.4 equiv.) and the reaction was allowed to stir for 24 hours. An additional 0.1 equivalents of titanium (IV) *iso*-propoxide was added to the mixture and allowed to stir to take the reaction to full conversion 9-fluorenone. Methanol (6 mL) was added to the resulting reaction mixture before it was cooled in ice-bath and sodium borohydride (2.43 g, 64.1 mmol, 4.0 equiv.) was added portion-wise. On completion of reaction 10 % aqueous sodium hydroxide was added to the reaction

mixture which was allowed to stir for 10 minutes before being filtered through Celite and washed with ethyl acetate/triethylamine (9:1). The solution was evaporated until all of the organic solvents had been removed, then the aqueous was extracted with ethyl acetate (3 x 50 mL). The organic phase was washed with brine, dried over sodium sulfate and filtered before the concentrated organic was purified on silica eluting with solvent gradient of *n*-hexane:ethyl acetate (80:20 increasing to 50:50). Concentration of fractions containing product yielded N^1-(9H-fluoren-9-yl)-N^2-mesitylethane-1,2-diamine (4.53 g, 13.2 mmol, 83 %) as pale yellow crystalline solid.[1]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.69 (m, 2H), 7.65 – 7.58 (m, 2H), 7.39 (tdd, J = 7.5, 1.3, 0.6 Hz, 2H), 7.32 (td, J = 7.4, 1.2 Hz, 2H), 6.84 – 6.78 (m, 2H), 2.98 – 2.92 (m, 2H), 2.74 – 2.68 (m, 2H) and 2.27 (d, J = 0.6 Hz, 6H), 2.23 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 145.7, 143.7, 140.7, 130.9, 129.4, 129.4, 128.1, 127.3, 124.9, 119.9, 63.5, 48.9, 45.3, 20.5.18.5.

Synthesis of 1-(9*H*-fluoren-9-yl)-3-mesityl-2-(perfluorophenyl)imidazolidine (9)



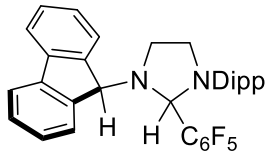
N^1-(9*H*-fluoren-9-yl)-N^2-mesitylethane-1,2-diamine (2.00 g, 5.84 mmol, 1.0 equiv.) and a few crystals of *p*-toluenesulfonic acid where dissolved in toluene (1.5 mL) with stiring. A spatula of sodium sulfate was added before pentafluorobenzaldehyde (1.17 g, 2.92 mmol, 1.0 equiv.) and the reaction mixture was allowed stir for 14 hours. The crude mixture was concentrated at the rotary evaporator before being purified on silica eluting with *n*-hexane:ethyl acetate (95:5) to afford a colourless oil after concentration. Addition of diethyl ether (2 mL) and further evaporation afforded an off white solid. Recrystallisation from *n*-pentane yielded 1-(9*H*-fluoren-9-yl)-3-mesityl-2-(perfluorophenyl)imidazolidine as colourless crystals (1.15 g, 2.21 mmol, 76 %). Melting point 109-110°C.[1]

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73-7.66 (m, 2H), 7.61 (d, J = 7.6 Hz, 1H), 7.49 (d, J = 7.5 Hz, 1H), 7.45-7.39 (m, 1H), 7.35 (td, J = 7.4, 1.2 Hz, 1H), 7.26 (t, J = 7.4 Hz, 1H), 7.11 (td, J = 7.5, 1.0 Hz, 1H), 6.71 (s, 2H), 5.58 (s, 1H), 5.13 (s, 1H), 3.76-3.66 (m, 1H), 3.65-3.60 (m, 1H), 3.56-3.51 (m, 1H), 3.30-3.25 (m, 1H), 2.17 (s, 3H), 2.04 (br. d, J = 26.9 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 144.0, 143.6, 141.1, 140.9, 139.5, 135.6, 128.8, 128.3, 127.6, 126.7, 126.1, 125.9, 119.9, 119.8, 77.5, 77.2, 76.8, 70.8, 64.2, 50.8, 49.6, 20.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -137.85 (dd, J = 22.7, 8.0 Hz), -148.36 (dd, J = 22.6, 8.0 Hz), -156.71 (t, J = 20.8 Hz) and -163.93 (dtd, J = 250.1, 22.2, 21.8, 8.1 Hz).

Synthesis of 1-(2,6-diisopropylphenyl)-3-(9*H*-fluoren-9-yl)-2-(perfluorophenyl) imidazolidine (10)



9-Fluorenone (4.00 g, 22.0 mmol, 1.1 equiv.) was dissolved in the minimum volume of methanol with vigorous stirring. Titanium(IV) *iso*-propoxide (6.64 mL, 22.0 mmol, 1.1 equiv.) was added, followed by *N*^{1}-(2,6-diisopropylphenyl)ethane-1,2-diamine (4.4 g, 20 mmol, 1.4 equiv.) and the reaction was allowed to stir for 24 hours. An additional 0.1 equivalents of 9-fluorenone and titanium(IV) *iso*-propoxide were added and allowed to react for a further hour before the reaction mixture was cooled in an ice bath. Sodium borohydride (3.02 g, 80 mmol, 4.0 equiv.) was added portion-wise. On completion of reaction water (50 mL) was added and the reaction mixture was concentrated *in vacuo*. The aqueous phase was then extracted with 50:50 ethyl acetate/diethyl ether (3×75 mL). The combined organic phase was washed with water and brine (100 mL), dried over magnesium sulfate, filtered and concentrated *in vacuo*. The crude yellow oil was dissolved in DCM (50 mL) with a few crystals of *p*-toluenesulfonic acid. A spatula of sodium sulfate was added before pentafluorobenzaldehyde (2.52 g, 20 mmol, 1.0 equiv.) and the reaction mixture was allowed stir for 14 hours. The crude mixture was concentrated at the rotary evaporator before being purified on silica eluting with a solvent gradient of 1%, 2% and 3% *n*-hexane/ethyl acetate. Recrystallization from *n*-pentane yielded off-white crystals (3.50 g, 6.22 mmol, 31%). Melting point 123-124°C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, J = 7.4 Hz, 1H), 7.67 (d, J = 7.3 Hz, 1H), 7.58 (d, J = 7.6 Hz, 1H), 7.44 (t, J = 8.2 Hz, 2H), 7.38 (td, J = 7.4, 1.3 Hz, 1H), 7.28-7.23 (m, 1H), 7.12 (t, J = 7.6 Hz, 1H), 7.09 (td, J = 7.5, 1.1 Hz, 1H), 7.03 (dd, J = 7.7, 1.7 Hz, 1H), 6.91 (dd, J = 7.5, 1.7 Hz, 1H), 5.40 (s, 1H), 5.18 (s, 1H), 3.90-3.77 (m, 1H), 3.76-3.59 (m, 1H), 3.51-3.32 (m, 1H), 2.95 (hept, J = 6.8 Hz, 1H), 1.15 (d, J = 6.8 Hz, 3H), 1.08 (d, J = 6.9 Hz, 3H), 1.04 (d, J = 6.8 Hz, 3H) and 0.52 ppm (d, J = 7.0 Hz, 3H).

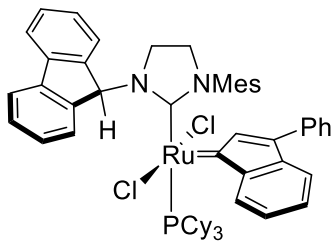
^{13}C NMR (101 MHz, $CDCl_3$) δ 149.9 (d, J = 177.7 Hz), 143.6 (d, J = 37.5 Hz), 140.8 (d, J = 43.5 Hz), 138.8, 129.0-128.4 (m), 128.4-128.0 (m), 127.9-127.3 (m), 127.2, 126.4, 125.9 (dd, J = 20.7, 7.4 Hz), 124.9, 123.5, 119.7 (dd, J = 23.5, 7.2 Hz), 72.6, 64.1 (d, J = 11.7 Hz), 55.3-51.7 (m), 49.8 , 28.1, 27.4-26.5 (m), 25.1 (t, J = 5.2 Hz), 23.8, 23.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -137.34 (dd, J = 23.3, 8.0 Hz), -148.10 (dd, J = 22.9, 7.9 Hz), -156.87 (t, J = 20.8 Hz), -164.01 (td, J = 22.1, 8.0 Hz), -164.24 (td, J = 22.2, 7.7 Hz).

HRMS (ESI) : *m/z* cald for $C_{34}H_{31}N_2F_5$ $[M+H]^+$ 563.2480, found 563.2505.

Preparation of unsymmetrical ruthenium complexes

Synthesis of complex Ru9



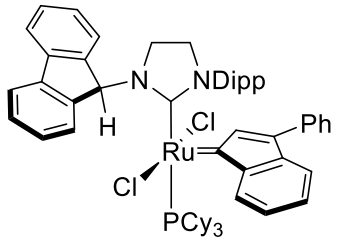
Umicore M1 (692 mg, 0.75 mmol, 1.5 equiv.), the pentafluorobenzene adduct (260 mg, 0.5 mmol, 1.0 equiv.) and copper(I) chloride (50 mg, 0.5 mmol, 1.0 equiv.) where weighed into an oven dried Schlenk under argon sealed with a septum. Dry degassed toluene (1 mL) was injected through the septum and then evaporated to dryness with stirring, the process was repeated once more (azeotrope). Toluene (3 mL) was added and the reaction mixture heated to 80 °C for 30 minutes before allowing to cool to room temperature. The reaction progress may be followed by TLC, *n*-hexane:ethyl acetate (90:10). The cooled reaction mixture was concentrated at the rotatory evaporator before being purified on a short column of silica eluting with *n*-hexane:ethyl acetate (90:10), fractions with NHC complex were concentrated and recolumned eluting with 95:5 *n*-hexane:ethyl acetate to afford the product (330 mg, 0.33 mmol, 66 %).[1]

^{1}H NMR (400 MHz, CD_2Cl_2) 8.55 (dd, J = 7.4, 1.3 Hz, 1H), 8.50 (td, J = 7.2, 1.0 Hz, 2H), 7.86-7.77 (m, 2H), 7.77-7.72 (m, 2H), 7.57-7.38 (m, 8H), 7.32 (s, 1H), 7.29-7.17 (m, 2H), 7.07 (dd, J = 7.0, 1.3 Hz, 1H), 6.42 (s, 1H), 6.03 (s, 1H), 3.76 – 3.53 (m, 2H), 3.31 (t, J = 10.2 Hz, 2H), 2.47-2.27 (m, 3H), 2.19 (s, 3H), 2.08 (s, 3H), 1.89 (s, 3H), 1.75-1.60 (m, 8H), 1.43-1.16 (m, 21H), 1.11 – 0.80 (m, 11H), 0.77-0.59 (m, 3H).

^{13}C NMR (101 MHz, CD_2Cl_2) δ 216.8 (d, J = 68.8 Hz), 143.9, 141.2, 141.1, 141.0, 140.4, 137.3, 137.2, 137.2, 136.9, 136.8, 136.7, 136.6, 136.3, 129.2, 129.2, 128.9, 128.6, 128.6, 128.4, 127.9, 127.6, 127.6, 127.6, 127.3, 127.1, 126.3, 119.7, 119.6, 116.0, 64.2, 52.0, 43.8, 43.8, 32.1, 31.9, 31.9, 29.5, 29.5, 29.3, 27.7, 27.6, 27.5, 27.4, 26.9, 26.2, 26.2, 22.7, 22.4, 20.7, 18.2, 18.1 and 13.9.

^{31}P NMR (162 MHz, CD_2Cl_2) δ 36.4.

Synthesis of complex Ru10



The pentafluorobenzene adduct (338 mg, 0.600 mmol, 1.1 equiv.) was weighed into an oven dried Schlenk flask under argon and dissolved in dry toluene (3 mL). Umicore M1 (504 mg, 0.545 mmol, 1.0 equiv.) was added and the resulting red/brown reaction mixture was stirred at 90 °C (in preheat oil bath). The reaction mixture was monitored by TLC over a period of 5 hours as significant amounts of start material appeared to be present. Phosphine scavenger copper(I) chloride (27 mg, 0.273 mmol, 0.5 equiv.) was added and the mixture was reacted for a further hour. After cooling the reaction mixture was diluted with *n*-hexane (10 mL) and placed onto a short column packed in neat hexane. The column was eluted with neat hexane to remove toluene before eluting with 1% ethyl acetate/*n*-hexane until all start material had been removed then the polarity was gradually in increased to 5% (in 1% increments) to elute the product. After evaporation the product was recrystallized from *n*-hexane affording product as a red crystalline solid (200 mg, 193 mmol, 35%).

^{1}H NMR (400 MHz, CD_2Cl_2) δ 8.77 (dd, J = 7.4, 1.3 Hz, 1H), 8.69-8.55 (m, 1H), 8.34 (dd, J = 7.4, 1.0 Hz, 1H), 7.83-7.75 (m, 2H), 7.65 – 7.57 (m, 3H), 7.56-7.35 (m, 7H), 7.29-7.15 (m, 2H), 7.14-7.04 (m, 1H), 6.90 (s, 1H), 6.85 (t, J = 7.7 Hz, 1H), 6.59 (ddd, J = 26.4, 7.8, 1.5 Hz, 2H), 4.09-3.87 (m, 1H), 3.83 – 3.66 (m, 1H), 3.55-3.40 (m, 1H), 3.36-3.17 (m, 2H), 3.02 (hept, J = 6.6 Hz, 1H), 2.45-2.19 (m, 3H), 1.76 (d, J = 13.9 Hz, 6H), 1.55-1.35 (m, 5H), 1.28 (dt, J = 12.3, 3.1 Hz, 8H), 1.21 (d, J = 6.6 Hz, 3H), 1.03 (d, J = 6.9 Hz, 3H), 0.85 (d, J = 6.8 Hz, 3H), 0.74 (d, J = 6.6 Hz, 3H).

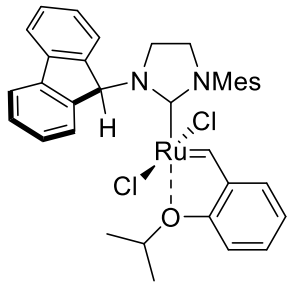
^{13}C NMR (101 MHz, CD_2Cl_2) δ 216.9 (d, J = 71.2 Hz), 147.7, 147.1, 144.6, 142.1, 141.8, 141.7, 141.7, 141.6, 139.0, 137.5, 137.4, 137.2, 130.7, 129.8, 129.1, 128.9, 128.3, 128.2, 128.1, 128.1, 128.1, 127.9, 127.3, 124.3, 123.8, 120.3, 116.9, 65.0, 55.6, 44.0, 43.9, 32.9, 32.7, 30.2, 29.7 , 28.5, 28.3, 28.2, 28.2, 28.1, 28.1, 27.5, 27.4, 27.1, 26.7, 26.0, 23.3, 22.5.

^{31}P NMR (162 MHz, CD_2Cl_2) δ 31.62.

IR (neat): *v* 3052, 2926, 2849, 1588, 1537, 1476, 1436, 1838, 1358, 1338, 1322, 1295, 1257, 1200, 1173, 1130, 1107, 1048, 1027, 1005, 977, 949, 916, 886, 848, 819, 801, 774, 747, 697, 681, 647, 621, 583, 555, 505, 490, 420 cm^{-1}.

HRMS (ESI) : *m/z* calcd for $C_{61}H_{73}Cl_2N_2PRu$ $[M]^+$ 1036.3932, found 1036.3932.

Synthesis of complex Ru11



Hoveyda-Grubbs I (210 mg, 0.35 mmol, 1 equiv.) and the corresponding pentafluorobenzene adduct (200 mg, 0.385 mmol, 1.1 equiv.) were weighed into an oven dried Schlenk tube under argon and sealed with a septum. Toluene (3 mL) was added and the reaction mixture was heated to 90 °C (in preheated oil bath) for 30 minutes, monitoring progress by TLC. Copper(I) chloride (38.5 mg, 0.385 mmol, 1.1 equiv.) was added, reaction mixture was heated for a further 10 mins. The cooled reaction mixture was poured on to a column of silica packed in neat hexane and flushed with neat hexane until the toluene was removed. The column was then eluted with a silica's length of 5% and then 10% ethyl acetate/*n*-hexane collecting a red/brown fraction, the product was then eluted with 20% ethyl acetate/*n*-hexane. Fractions containing product were concentrated *in vacuo*, the crude product was redissolved in DCM and MeOH and concentrated at the rotary evaporator without heating. After evaporation of DCM, the methanol and other liquids were removed with a syringe from the green crystals. The process was once again repeated. The product crystallized as lustrous dark green crystals (175 mg, 0.26 mmol, 74%).

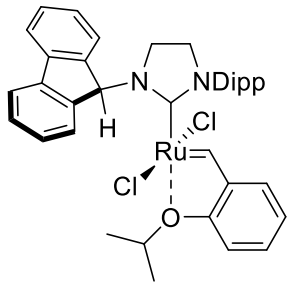
^{1}H NMR (400 MHz, CD_2Cl_2) δ 16.25 (s, 1H), 8.37 (d, J = 7.5 Hz, 2H), 7.81 (dd, J = 7.5, 1.0 Hz, 2H), 7.59 (dddd, J = 8.5, 5.2, 3.8, 0.9 Hz, 1H), 7.49 (td, J = 7.5, 0.9 Hz, 2H), 7.41 (tt, J = 7.6, 1.1 Hz, 2H), 7.29 (s, 1H), 7.13 (s, 2H), 7.01 (d, J = 0.9 Hz, 2H), 7.00-6.98 (m, 1H), 5.14 (dq, J = 12.4, 6.2 Hz, 1H), 3.89-3.78 (m, 2H), 3.32-3.22 (m, 2H), 2.49 (s, 3H), 2.29 (s, 6H), 1.62 (dd, J = 6.2, 0.9 Hz, 6H), 1.53 (d, J = 0.9 Hz, 2H).

^{13}C NMR (101 MHz, CD_2Cl_2) δ 209.1, 152.8, 144.6, 142.4, 141.6, 139.6, 138.6, 138.5, 130.1, 129.7, 128.3, 127.7, 123.1, 122.9, 120.4, 113.5, 76.0, 75.9, 65.3, 65.3, 43.9, 22.3, 21.5, 18.4, 18.4.

IR (neat): ν= 2975, 1473, 1436, 1411, 1327, 1260, 1217, 1156, 1109, 1096, 933, 842, 747, 680 cm^{-1}.

HRMS (ESI): *m/z* calcd for $C_{35}H_{36}Cl_2N_2ORuNa$ $[M+Na]^+$ 695.1146, found 695.1123.

Synthesis of complex Ru12



Hoveyda-Grubbs I catalyst (485 mg, 0.81 mmol, 1 equiv.) and the corresponding pentafluorobenzene adduct (500 mg, 0.89 mmol, 1.1 equiv.) were added to a Schlenk flask and argonated. Dry toluene (6 mL) was added and the resulting dark brown mixture was stirred for about 30 min at 80°C. The reaction was monitored by TLC. When the reaction was complete, phosphine scavenger copper(I) chloride (121 mg, 1.21 mmol, 1.5 equiv.) was added and the mixture was stirred for a further 10 min and checked by TLC. After cooling the mixture was put onto column packed in neat hexane and then eluted with *n*-hexane to remove the toluene. The column was eluted with the silica's length of 5% ethyl acetate/*n*-hexane followed by 10% ethyl acetate/*n*-hexane until the red-brown fraction was collected. The product was then eluted with 20% ethyl acetate/*n*-hexane. Product fractions were checked by TLC, collected into one flask, concentrated to dryness and recrystallized from DCM/MeOH on the rotary evaporator. The product was obtained as lustrous dark green crystals (389 mg, 0.54 mmol, 67%).

^{1}H NMR (400 MHz, CD_2Cl_2) δ 16.23 (d, J = 0.9 Hz, 1H), 8.41-8.37 (m, 2H), 7.82 (ddd, J = 7.5, 1.2, 0.7 Hz, 2H), 7.69-7.61 (m, 1H), 7.56 (ddd, J = 8.3, 6.1, 3.0 Hz, 1H), 7.50 (tdd, J = 7.5, 1.2, 0.6 Hz, 2H), 7.47-7.39 (m, 4H), 7.34 (s, 1H), 7.00 (dt, J = 8.3, 0.7 Hz, 1H), 6.96-6.92 (m, 2H), 5.19-5.08 (m, 1H), 3.94-3.72 (m, 2H), 3.35 – 3.15 (m, 4H), 1.65 (d, J = 6.1 Hz, 6H), 1.22 (d, J = 7.0 Hz, 6H), 0.95 (d, J = 6.7 Hz, 6H).

^{13}C NMR (101 MHz, CD_2Cl_2) δ 149.0, 142.4, 141.6, 130.2, 130.0, 129.7, 128.3, 127.7, 125.4, 123.0, 122.6, 120.3, 113.5, 76.0, 65.5, 55.6, 43.6, 28.6, 25.9, 24.2, 22.5.

IR (neat): *v* 3063, 3049, 2923, 2892, 2866, 1958, 1918, 1823, 1720, 1604, 1588, 1575, 1477, 1449, 1429, 1419, 1384, 1337, 1316, 1294, 1266, 1249, 1217, 1177, 1158, 1142, 1111, 1098, 1049, 1037, 1021, 1003, 981, 951, 932, 879, 842, 810, 794, 756, 745, 680, 657, 640, 620, 582, 492, 438, 418 cm^{-1}.

HRMS (ESI): *m/z* calcd for $C_{38}H_{42}Cl_2N_2ORuNa$ $[M+Na]^+$ 737.1615, found 695.1608.

General procedure for thermal stability studies

In a Young NMR tube corresponding catalyst (12.8 μmol) was dissolved in 0.65 mL of toluene-d_8 followed by addition of 0.13 M solution of 1,3,5-trimethoxybenzene in toluene-d_8 (internal standard, 50 μL, 6.4 μmol) in a glove box. An NMR tube was removed from glove box and placed in preheated (50 °C) water batch. ^{1}H NMR spectra were recorded in frequent time

intervals. Degradation of catalyst was calculated by comparing the integration of benzylidene and indenylidene signal in complexes and 9 protons from methoxy groups in internal standard.

General procedure for time-conversions studies (Figures 5 and 6)

All manipulation were carried out in glove box. An NMR tube was filled with 117mM stock solution of appropriate substrate (0.6 mL, 70 μmol) in toluene-d_8. The solution was heated to corresponding temperature and equilibrated for 3 min. Catalyst (0.1 mL, 0.7 μmol) was taken from the 7 mM stock solution in toluene-d_8 and injected into preheated NMR tube. The process was monitored using Agilent array function over an appropriate time intervals. Conversion was calculated by comparing the integration of methylene protons in substrate and product, based on equation Yield (%) = ([P] × 100%)/([P]+[S]).

General procedure for model RCM reactions (Table 2)

The substrate was accurately weighed into a Radley carousel under inert atmosphere and dissolved in dry toluene (3.8 mL) with stirring. In the glove-box the catalyst (0.01 mmol) was dissolved in dry toluene (2 mL), 0.2 mL of this stock solution was transferred to the reaction mixture and heated at 80°C overnight under a flow of argon. The reaction was cooled, quenched with SnatchCat and concentrated in *vacuo* before being dispersed on 70-230 Silica and purifying on the Combi-flash. Concentration of fractions afforded the pure products.

^{1}H NMR analysis was done to determine the structure of each product.

General procedure for α-olefin metathesis (Figure 7)

In the glovebox a stock solution of catalyst was made up in a 1 mL volumetric flask. A solution of 1-octene (1.5 mL, 9.37 mmol) in tetradecane (0.5 mL, 1.9 mmol) as internal standard was stirred at certain temperature before a sample without catalyst was taken. The appropriate volume of stock solution was added *via* micro syringe to the reaction mixture before reaction samples (0.1 mL) for GC analysis were taken at relevant time intervals. Samples were quenched with SnatchCat solution (35 μmol, 1 mL). Conversion and selectivity were determined by GC measurement according to the calculations below.

The conversions and selectivities were calculated according to the formulas below:

$$Conversion\ (\%) = \frac{A_{initial} - A_x}{A_{initial}} \cdot 100\%$$

$A_{initial}$ - initial amount of substrate

A_x - amount of substrate at given time

$$Selectivity(\%) = \frac{A_{product}}{A_{total} - A_{susbtrate} - A_{standard}} \cdot 100\%$$

$A_{product}$ - amount of product at given time

$A_{substrate}$ - amount of substrate at given time

$A_{standard}$ - amount of standard at given time

A_{total} - amount of every compound at given time

Table S1. Supporting information for Figure 7a.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	80,71	0,00	19,29
0,1	65,48	98%	34,52	64,29	1,19
0,3	78,27	96%	21,73	75,37	2,90
0,5	83,09	93%	16,91	77,54	5,55
0,8	86,53	92%	13,47	79,29	7,24
1,0	89,00	91%	11,00	81,17	7,83
1,5	91,01	89%	8,99	80,89	10,12
2,0	93,04	88%	6,96	81,99	11,06
3,0	95,50	87%	4,50	83,12	12,37

Table S2. Supporting information for Figure 7b.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	100,00	0,00	0,00
0,1	4,75	66%	95,25	3,78	6,85
0,3	12,80	88%	87,20	11,96	8,12
0,5	25,06	94%	74,94	24,28	1,57
0,8	36,57	95%	63,43	35,75	2,12
1,0	42,90	96%	57,10	42,08	1,60
1,5	55,51	97%	44,49	54,49	1,56
2,0	65,67	97%	34,33	64,53	1,83
3,0	79,01	97%	20,99	76,71	2,06

Table S3. Supporting information for Figure 7c.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	141,89	0,00	0,00
0,1	0,00	82%	133,01	0,00	0,00
0,3	0,00	94%	121,70	0,00	0,00
0,5	0,00	97%	105,76	0,00	0,00
0,8	7,75	98%	92,25	7,56	0,19

1,0	16,98	98%	83,02	16,62	0,36
1,5	33,56	98%	66,44	32,93	0,64
2,0	50,43	97%	49,57	48,98	1,45
3,0	65,47	97%	34,53	63,45	2,02
21,0	84,29	91%	15,71	76,90	7,40

Table S4. Supporting information for Figure 7d.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	Other
0,0	0,00	0%	141,54	0,00	0,00
0,1	0,00	7%	143,57	0,00	0,00
0,3	0,00	51%	143,61	0,00	0,00
0,5	0,00	69%	137,85	0,00	0,00
0,8	0,00	82%	126,61	0,00	0,00
1,0	0,00	87%	135,78	0,00	0,00
1,5	0,00	92%	117,61	0,00	0,00
2,0	0,00	94%	112,67	0,00	0,00
3,0	9,52	91%	90,48	8,66	0,85
4,0	17,32	93%	82,68	16,06	1,26
5,0	27,18	94%	72,82	25,61	1,56
6,0	33,39	94%	66,61	31,43	1,96
7,0	40,60	94%	59,40	38,35	2,25
8,0	46,09	95%	53,91	43,94	2,14
19,5	65,30	92%	34,70	59,95	5,36
20,5	67,65	91%	32,35	61,31	6,34

Table S5. Supporting information for Figure 7e.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	142,07	0,00	0,00
0,1	0,00	1%	140,06	0,00	0,00
0,3	0,00	2%	141,83	0,00	0,00
0,5	0,00	7%	137,90	0,00	0,00
0,8	0,00	31%	142,81	0,00	0,00
1,0	0,00	40%	155,74	0,00	0,00
1,5	0,00	69%	134,94	0,00	0,00
2,0	0,00	71%	127,01	0,00	0,00
3,0	0,00	87%	121,87	0,00	0,00
4,0	0,00	86%	118,71	0,00	0,00
5,0	0,00	82%	107,54	0,00	0,00
6,0	0,00	85%	100,80	0,00	0,00
7,0	4,47	90%	95,53	4,04	0,42
8,0	11,32	90%	88,68	10,21	1,11
19,5	23,97	89%	76,03	21,38	2,60
21,0	32,29	89%	67,71	28,78	3,51

Table S6. Self-metathesis of 1-octene performed in the presence of **Ru10** (50 ppm) at 50 °C.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	127,19	0,00	0,00
0,1	39,72	90%	60,28	35,93	3,79
0,5	61,68	92%	38,32	56,61	5,07
0,8	70,07	91%	29,93	63,81	6,26
1,0	70,23	93%	29,77	65,06	5,17
1,5	76,67	94%	23,33	72,00	4,66
2,0	79,87	93%	20,13	74,61	5,25
3,0	81,56	90%	18,44	73,52	8,04

Table S7. Self-metathesis of 1-octene performed in the presence of **Ru11** (50 ppm) at 50 °C.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	Other
0,0	0,00	0%	141,10	0,00	0,00
0,1	40,83	67%	59,17	27,34	13,49
0,3	54,73	93%	45,27	50,83	3,90
0,5	61,20	89%	38,80	54,75	6,45
0,8	62,74	90%	37,26	56,15	6,58
1,5	70,29	87%	29,71	61,46	8,83
2,0	72,53	90%	27,47	64,99	7,54
3,0	74,80	92%	25,20	69,12	5,68

Table S8. Self-metathesis of 1-octene performed in the presence of **Ru12** (50 ppm) at 50 °C.

Time [h]	Conversion [%]	Selectivity	1-octene	7-tetradecene	other
0,0	0,00	0%	86,27	0,00	13,73
0,1	48,21	89%	51,79	43,14	5,06
0,3	66,57	91%	33,43	60,71	5,86
0,5	72,65	92%	27,35	66,91	5,74
1,0	79,81	94%	20,19	74,86	4,95
1,5	81,62	93%	18,38	75,98	5,64
2,0	82,92	90%	17,08	74,66	8,26
3,0	84,60	94%	15,40	79,78	4,83

General procedure for ethenolysis reaction (Figure 8)

Into a dry autoclave tube charged with ethyl oleate (**28**) (purified by passing through an Al_2O_3 pad, 4.66 g, 15 mmol) and tetradecane (internal standard, 0.61g, 3 mmol), catalyst (100 ppm) was added in 0.1 mL of HPLC grade DCM. Autoclave was closed, purged with ethylene (3 times) and stirred at 50 °C for 3 h with 10 bar continuous ethylene pressure. On completion the reaction was quenched by ethyl-vinyl ether addition. Conversion and selectivity were determined by GC measurement.

Crystallographic information

Good quality single-crystals of **Ru9**-**Ru12** were selected for X-ray diffraction data collection performed at T = 100(2) K. They were mounted with paratone-N oil at the MiTeGen micro-mounts. Diffraction data were collected on the Agilent Technologies SuperNova Dual Source diffractometer with Cu$K\alpha$ (λ = 1.54184 Å) (**Ru9**-**Ru11**) and Mo$K\alpha$ (λ = 0.71073 Å) (**Ru12**) radiation using the CrysAlis RED software.[2] The analytical numerical absorption correction using a multifaceted crystal model based on expressions derived by R.C. Clark & J.S. Reid[3] (**Ru9** and **Ru10**) and numerical absorption correction based on gaussian integration over a multifaceted crystal model (**Ru11** and **Ru12**) implemented in SCALE3 ABSPACK scaling algorithm were applied.[2] The structural determination procedure was carried out using the SHELX package.[4] The structures were solved with direct methods and then successive least-square refinement was carried out based on the full-matrix least-squares method on F^2 using the SHELXL program.[4] The crystals of **Ru9** and **Ru11** were twinned and the structures were refined using the twin laws [-1 0 0, 0 -1 0, 0 0 -1] and [-1 0 0, 0 1 0, 0 0 -1] for **Ru9** and **Ru11**, respectively. The batch scale factors refined for **Ru9** and **Ru11** were 0.389(18) and 0.346(11), respectively. All H-atoms were positioned geometrically, with the C–H distances equal to 0.93, 0.96, 0.97 and 0.98 Å for the aromatic/methylidene, methyl, methylene and methine H-atoms, respectively, and constrained to ride on their parent atoms with U_{iso}(H) = xU_{eq}(C), where x = 1.2 for the aromatic/methylidene, methylene and methine H-atoms, and x = 1.5 for the methyl H-atoms. All molecular interactions in crystals of investigated complexes were identified using PLATON program.[5] The figures were prepared using *ORTEP-3* and *Olex2* programs.[6-7]

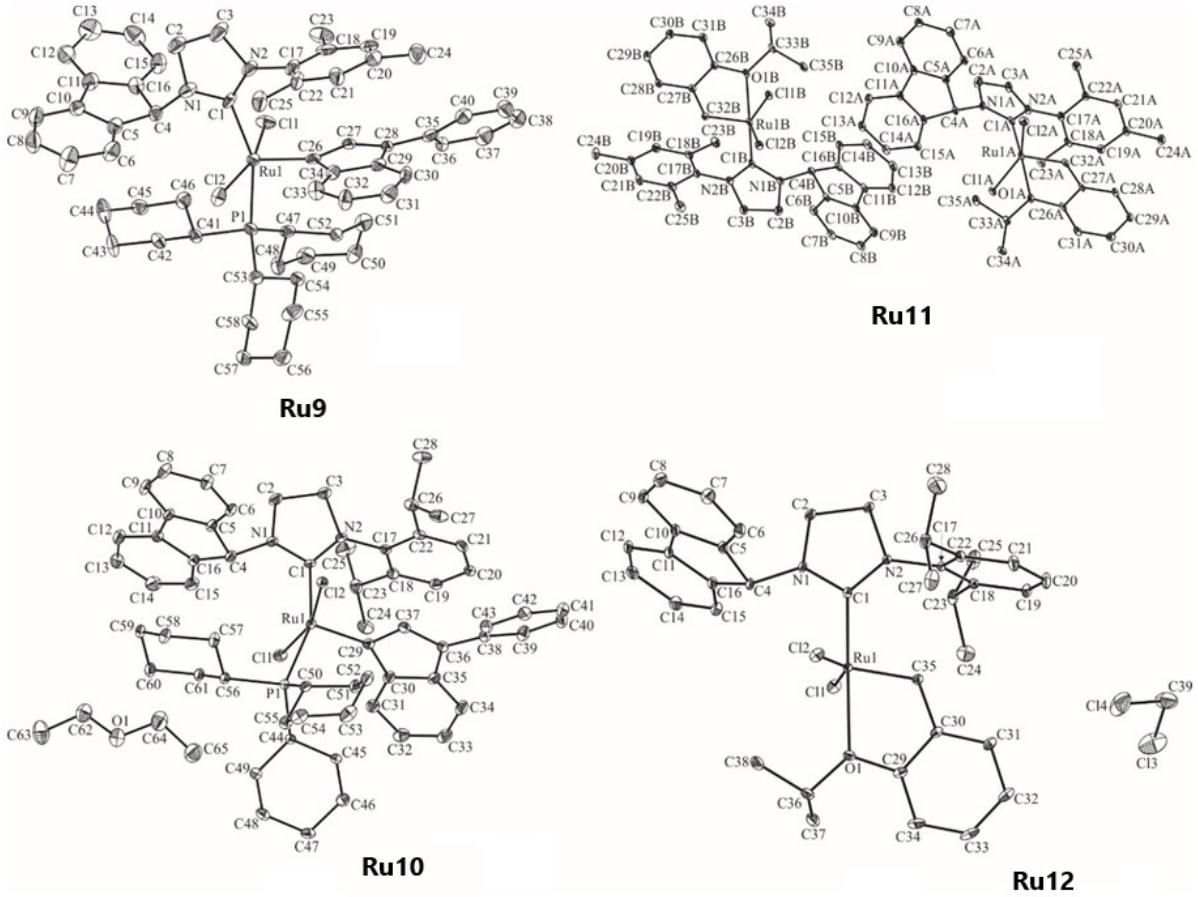


Figure S1. Asymmetric unit of the crystal lattice of **Ru9**-**Ru12** complexes with atom labelling scheme. Displacement ellipsoids are drawn at the 25% probability level. The hydrogen atoms have been omitted for clarity.

Table S6. Crystallographic data and structural refinement details of **Ru9**-**Ru12**.

Compound	**Ru9**	**Ru10**	**Ru11**	**Ru12**
Empirical formula	$C_{58}H_{67}Cl_2N_2PRu$	$C_{61}H_{73}Cl_2N_2PRu$, $C_4H_{10}O$	$C_{35}H_{36}Cl_2N_2ORu$	$C_{38}H_{42}Cl_2N_2ORu$, CH_2Cl_2
Formula weight	995.08	1111.27	672.63	799.63
Temperature/K	100(2)	100(2)	100(2)	100(2)
Crystal system	Orthorhombic	Orthorhombic	Orthorhombic	Monoclinic
Space group	$P2_12_12_1$	$P2_12_12_1$	$Pbc2_1$	$P2_1/c$
a/Å	15.4542(6)	13.32909(13)	11.95861(6)	9.8980(3)
b/Å	17.3606(6)	14.36540(15)	14.69955(10)	16.4168(4)
c/Å	19.0737(7)	30.1298(3)	34.87251(18)	23.4599(5)
β/°	90.00	90.00	90.00	99.710(2)
Volume/Å^3	5117.4(3)	5769.19(10)	6130.11(6)	3757.47(16)
Z	4	4	8	4
ρ_{calc}/g/cm^3	1.292	1.279	1.458	1.414
μ/mm^{-1}	4.023	3.634	5.977	0.735
F(000)	2088	2352	2768	1648
Crystal size/mm	0.18 × 0.10 × 0.06	0.23 × 0.09 × 0.05	0.13 × 0.11 × 0.09	0.37 × 0.08 × 0.06
Radiation	Cu$K\alpha$ (λ = 1.54184 Å)	Cu$K\alpha$ (λ = 1.54184 Å)	Cu$K\alpha$ (λ = 1.54184 Å)	Mo$K\alpha$ (λ = 0.71073 Å)
2Θ range for data collection/°	3.44 to 67.08	2.93 to 76.55	2.53 to 76.92	2.14 to 32.10
Index ranges	-18 ≤ h ≤ 17, -18 ≤ k ≤ 20, -22 ≤ l ≤ 22	-16 ≤ h ≤ 16, -15 ≤ k ≤ 17, -37 ≤ l ≤ 37	-14 ≤ h ≤ 14, -15 ≤ k ≤ 17, -41 ≤ l ≤ 41	-14 ≤ h ≤ 14, -23 ≤ k ≤ 22, -33 ≤ l ≤ 32
Reflections collected	20495	137166	112582	35168
Independent reflections	9138 [R_{int} = 0.0434, R_{sigma} = 0.0598]	11598 [R_{int} = 0. 0.0609, R_{sigma} = = 0.0350]	10929 [R_{int} = 0.1268, R_{sigma} = 0.0467]	11469 [R_{int} = 0.0357, R_{sigma} = 0.0409]
Data/restraints/parameters	9138/0/581	11898/0/655	10929/1/750	11469/0/430
Goodness-of-fit on F^2	1.117	1.042	1.048	1.084
Final R indexes [I>=2σ (I)]	R_1 = 0.0888, wR_2 = 0.2259	R_1 = 0.0414, wR_2 = 0.0947	R_1 = 0.0467, wR_2 = 0.1196	R_1 = 0.0433, wR_2 = 0.0924

Final *R* indexes [all data]	R_1 = 0.0939, wR_2 = 0.2301	R_1 = 0.0439, wR_2 = 0.0960	R_1 = 0.0481, wR_2 = 0.1216	R_1 = 0.0532, wR_2 = 0.0965
Largest diff. peak/hole / e Å^{-3}	2.89/-0.87	1.44/-1.03	1.34/-0.85	1.44/-1.40
Absolute structure parameter	0.00(8)	-0.026(4)	0.007(7)	-

Table S7. Bond lengths for **Ru9**.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C(1)	N(1)	1.324(12)	C(28)	C(35)	1.452(14)
C(1)	N(2)	1.333(13)	C(29)	C(30)	1.396(14)
C(1)	Ru(1)	2.076(9)	C(29)	C(34)	1.408(14)
C(2)	C(3)	1.499(17)	C(30)	C(31)	1.360(16)
C(2)	N(1)	1.489(13)	C(31)	C(32)	1.358(16)
C(3)	N(2)	1.484(14)	C(32)	C(33)	1.410(15)
C(4)	C(5)	1.530(14)	C(33)	C(34)	1.411(13)
C(4)	C(16)	1.505(13)	C(35)	C(36)	1.366(14)
C(4)	N(1)	1.433(12)	C(35)	C(40)	1.466(16)
C(5)	C(6)	1.372(15)	C(36)	C(37)	1.388(15)
C(5)	C(10)	1.399(15)	C(37)	C(38)	1.436(19)
C(6)	C(7)	1.431(18)	C(38)	C(39)	1.375(16)
C(7)	C(8)	1.364(19)	C(39)	C(40)	1.369(16)
C(8)	C(9)	1.331(19)	C(41)	C(42)	1.543(13)
C(9)	C(10)	1.382(16)	C(41)	C(46)	1.509(13)
C(10)	C(11)	1.459(16)	C(41)	P(1)	1.867(10)
C(11)	C(12)	1.402(16)	C(42)	C(43)	1.557(14)
C(11)	C(16)	1.413(15)	C(43)	C(44)	1.463(18)
C(12)	C(13)	1.411(19)	C(44)	C(45)	1.565(16)
C(13)	C(14)	1.37(2)	C(45)	C(46)	1.536(15)
C(14)	C(15)	1.368(17)	C(47)	C(48)	1.536(13)
C(15)	C(16)	1.373(15)	C(47)	C(52)	1.542(13)
C(17)	C(18)	1.361(16)	C(47)	P(1)	1.857(9)
C(17)	C(22)	1.385(16)	C(48)	C(49)	1.549(15)
C(17)	N(2)	1.426(13)	C(49)	C(50)	1.528(16)
C(18)	C(19)	1.478(17)	C(50)	C(51)	1.519(15)
C(18)	C(23)	1.488(18)	C(51)	C(52)	1.527(12)
C(19)	C(20)	1.346(17)	C(53)	C(54)	1.527(15)
C(20)	C(21)	1.410(16)	C(53)	C(58)	1.534(15)
C(20)	C(24)	1.515(17)	C(53)	P(1)	1.832(10)
C(21)	C(22)	1.355(14)	C(54)	C(55)	1.506(13)
C(22)	C(25)	1.511(16)	C(55)	C(56)	1.516(18)
C(26)	C(27)	1.448(13)	C(56)	C(57)	1.524(18)
C(26)	C(34)	1.496(15)	C(57)	C(58)	1.536(15)
C(26)	Ru(1)	1.922(11)	Cl(1)	Ru(1)	2.378(2)
C(27)	C(28)	1.353(14)	Cl(2)	Ru(1)	2.384(2)
C(28)	C(29)	1.467(13)	P(1)	Ru(1)	2.440(2)

Table S8. Values of valence angles for **Ru9**.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
N(1)	C(1)	N(2)	110.0(8)	C(29)	C(34)	C(33)	119.7(9)
N(1)	C(1)	Ru(1)	119.4(7)	C(33)	C(34)	C(26)	134.2(10)
N(2)	C(1)	Ru(1)	130.6(7)	C(28)	C(35)	C(40)	120.2(9)
N(1)	C(2)	C(3)	102.1(9)	C(36)	C(35)	C(28)	122.3(11)
N(2)	C(3)	C(2)	104.1(9)	C(36)	C(35)	C(40)	117.4(10)
C(16)	C(4)	C(5)	102.2(8)	C(35)	C(36)	C(37)	121.7(11)
N(1)	C(4)	C(5)	113.0(9)	C(36)	C(37)	C(38)	121.1(10)

N(1)	C(4)	C(16)	112.3(8)	C(39)	C(38)	C(37)	117.0(11)
C(6)	C(5)	C(4)	129.7(11)	C(40)	C(39)	C(38)	122.9(12)
C(6)	C(5)	C(10)	119.9(11)	C(39)	C(40)	C(35)	119.9(10)
C(10)	C(5)	C(4)	110.4(9)	C(42)	C(41)	P(1)	112.9(7)
C(5)	C(6)	C(7)	118.5(12)	C(46)	C(41)	C(42)	109.9(8)
C(8)	C(7)	C(6)	119.1(12)	C(46)	C(41)	P(1)	114.0(7)
C(9)	C(8)	C(7)	122.5(12)	C(41)	C(42)	C(43)	111.2(9)
C(8)	C(9)	C(10)	119.9(12)	C(44)	C(43)	C(42)	113.3(9)
C(5)	C(10)	C(11)	108.2(10)	C(43)	C(44)	C(45)	113.1(11)
C(9)	C(10)	C(5)	120.2(11)	C(46)	C(45)	C(44)	106.5(9)
C(9)	C(10)	C(11)	131.6(11)	C(41)	C(46)	C(45)	115.2(9)
C(12)	C(11)	C(10)	132.0(12)	C(48)	C(47)	C(52)	108.8(7)
C(12)	C(11)	C(16)	118.9(11)	C(48)	C(47)	P(1)	117.9(7)
C(16)	C(11)	C(10)	109.1(9)	C(52)	C(47)	P(1)	112.3(7)
C(11)	C(12)	C(13)	117.5(13)	C(47)	C(48)	C(49)	109.1(9)
C(14)	C(13)	C(12)	120.8(13)	C(50)	C(49)	C(48)	110.8(10)
C(15)	C(14)	C(13)	122.4(12)	C(51)	C(50)	C(49)	112.4(8)
C(14)	C(15)	C(16)	117.5(11)	C(50)	C(51)	C(52)	110.8(9)
C(11)	C(16)	C(4)	110.0(8)	C(51)	C(52)	C(47)	107.6(8)
C(15)	C(16)	C(4)	127.2(9)	C(54)	C(53)	C(58)	109.3(8)
C(15)	C(16)	C(11)	122.6(10)	C(54)	C(53)	P(1)	115.0(7)
C(18)	C(17)	C(22)	121.8(10)	C(58)	C(53)	P(1)	117.3(9)
C(18)	C(17)	N(2)	119.6(11)	C(55)	C(54)	C(53)	109.8(9)
C(22)	C(17)	N(2)	118.4(10)	C(54)	C(55)	C(56)	111.4(10)
C(17)	C(18)	C(19)	116.9(11)	C(55)	C(56)	C(57)	113.6(10)
C(17)	C(18)	C(23)	122.2(13)	C(56)	C(57)	C(58)	110.7(9)
C(19)	C(18)	C(23)	120.9(12)	C(53)	C(58)	C(57)	109.6(11)
C(20)	C(19)	C(18)	121.6(12)	C(1)	N(1)	C(2)	112.3(9)
C(19)	C(20)	C(21)	117.4(12)	C(1)	N(1)	C(4)	128.1(8)
C(19)	C(20)	C(24)	121.3(12)	C(4)	N(1)	C(2)	118.9(8)
C(21)	C(20)	C(24)	121.2(11)	C(1)	N(2)	C(3)	111.0(9)
C(22)	C(21)	C(20)	122.8(12)	C(1)	N(2)	C(17)	130.1(8)
C(17)	C(22)	C(25)	121.3(9)	C(17)	N(2)	C(3)	118.3(8)
C(21)	C(22)	C(17)	119.5(11)	C(41)	P(1)	Ru(1)	109.6(3)
C(21)	C(22)	C(25)	119.2(11)	C(47)	P(1)	C(41)	102.2(5)
C(27)	C(26)	C(34)	106.4(8)	C(47)	P(1)	Ru(1)	114.6(3)
C(27)	C(26)	Ru(1)	122.4(9)	C(53)	P(1)	C(41)	103.3(5)
C(34)	C(26)	Ru(1)	131.2(7)	C(53)	P(1)	C(47)	111.9(4)
C(28)	C(27)	C(26)	109.7(10)	C(53)	P(1)	Ru(1)	113.9(4)
C(27)	C(28)	C(29)	109.1(9)	C(1)	Ru(1)	Cl(1)	86.5(3)
C(27)	C(28)	C(35)	125.7(10)	C(1)	Ru(1)	Cl(2)	89.6(3)
C(35)	C(28)	C(29)	125.0(10)	C(1)	Ru(1)	P(1)	156.3(3)
C(30)	C(29)	C(28)	132.5(10)	C(26)	Ru(1)	C(1)	102.0(4)
C(30)	C(29)	C(34)	119.0(9)	C(26)	Ru(1)	Cl(1)	96.6(3)
C(34)	C(29)	C(28)	108.5(9)	C(26)	Ru(1)	Cl(2)	100.6(3)
C(31)	C(30)	C(29)	120.3(10)	C(26)	Ru(1)	P(1)	101.6(2)
C(32)	C(31)	C(30)	122.0(11)	Cl(1)	Ru(1)	Cl(2)	162.80(10)
C(31)	C(32)	C(33)	119.8(10)	Cl(1)	Ru(1)	P(1)	89.05(8)
C(32)	C(33)	C(34)	118.9(10)	Cl(2)	Ru(1)	P(1)	87.77(9)
C(29)	C(34)	C(26)	106.2(8)				

Table S9. Values of torsion angles for **Ru9**.

A	B	C	D	Angle/˚	A	B	C	D	Angle/˚
C(2)	C(3)	N(2)	C(1)	-3.3(16)	C(35)	C(36)	C(37)	C(38)	0.7(17)

C(2)	C(3)	N(2)	C(17)	-175.9(11)	C(36)	C(35)	C(40)	C(39)	-2.0(15)
C(3)	C(2)	N(1)	C(1)	-6.7(15)	C(36)	C(37)	C(38)	C(39)	-2.2(17)
C(3)	C(2)	N(1)	C(4)	-177.3(11)	C(37)	C(38)	C(39)	C(40)	1.6(18)
C(4)	C(5)	C(6)	C(7)	-178.2(13)	C(38)	C(39)	C(40)	C(35)	0.5(18)
C(4)	C(5)	C(10)	C(9)	177.3(10)	C(40)	C(35)	C(36)	C(37)	1.4(14)
C(4)	C(5)	C(10)	C(11)	-3.3(12)	C(41)	C(42)	C(43)	C(44)	-52.2(14)
C(5)	C(4)	C(16)	C(11)	1.4(11)	C(41)	P(1)	Ru(1)	C(1)	-1.5(8)
C(5)	C(4)	C(16)	C(15)	176.0(11)	C(41)	P(1)	Ru(1)	C(26)	-177.2(5)
C(5)	C(4)	N(1)	C(1)	123.9(11)	C(41)	P(1)	Ru(1)	Cl(1)	-80.7(3)
C(5)	C(4)	N(1)	C(2)	-67.1(13)	C(41)	P(1)	Ru(1)	Cl(2)	82.4(3)
C(5)	C(6)	C(7)	C(8)	2(2)	C(42)	C(41)	C(46)	C(45)	-56.5(12)
C(5)	C(10)	C(11)	C(12)	-174.6(13)	C(42)	C(41)	P(1)	C(47)	173.0(7)
C(5)	C(10)	C(11)	C(16)	4.1(13)	C(42)	C(41)	P(1)	C(53)	56.7(8)
C(6)	C(5)	C(10)	C(9)	-1.5(18)	C(42)	C(41)	P(1)	Ru(1)	-65.1(7)
C(6)	C(5)	C(10)	C(11)	177.9(12)	C(42)	C(43)	C(44)	C(45)	55.6(15)
C(6)	C(7)	C(8)	C(9)	-2(3)	C(43)	C(44)	C(45)	C(46)	-55.5(13)
C(7)	C(8)	C(9)	C(10)	1(2)	C(44)	C(45)	C(46)	C(41)	56.9(12)
C(8)	C(9)	C(10)	C(5)	1(2)	C(46)	C(41)	C(42)	C(43)	50.5(12)
C(8)	C(9)	C(10)	C(11)	-178.6(14)	C(46)	C(41)	P(1)	C(47)	-60.6(8)
C(9)	C(10)	C(11)	C(12)	5(2)	C(46)	C(41)	P(1)	C(53)	-176.9(7)
C(9)	C(10)	C(11)	C(16)	-176.5(13)	C(46)	C(41)	P(1)	Ru(1)	61.3(7)
C(10)	C(5)	C(6)	C(7)	0(2)	C(47)	C(48)	C(49)	C(50)	55.8(12)
C(10)	C(11)	C(12)	C(13)	173.9(13)	C(47)	P(1)	Ru(1)	C(1)	112.7(8)
C(10)	C(11)	C(16)	C(4)	-3.4(12)	C(47)	P(1)	Ru(1)	C(26)	-63.0(5)
C(10)	C(11)	C(16)	C(15)	-178.3(11)	C(47)	P(1)	Ru(1)	Cl(1)	33.5(4)
C(11)	C(12)	C(13)	C(14)	6(2)	C(47)	P(1)	Ru(1)	Cl(2)	-163.4(4)
C(12)	C(11)	C(16)	C(4)	175.6(11)	C(48)	C(47)	C(52)	C(51)	64.4(10)
C(12)	C(11)	C(16)	C(15)	0.7(18)	C(48)	C(47)	P(1)	C(41)	-41.9(9)
C(12)	C(13)	C(14)	C(15)	-4(2)	C(48)	C(47)	P(1)	C(53)	68.0(10)
C(13)	C(14)	C(15)	C(16)	-1(2)	C(48)	C(47)	P(1)	Ru(1)	-160.4(7)
C(14)	C(15)	C(16)	C(4)	-171.9(11)	C(48)	C(49)	C(50)	C(51)	-52.7(13)
C(14)	C(15)	C(16)	C(11)	2.1(18)	C(49)	C(50)	C(51)	C(52)	55.7(13)
C(16)	C(4)	C(5)	C(6)	179.9(13)	C(50)	C(51)	C(52)	C(47)	-60.5(11)
C(16)	C(4)	C(5)	C(10)	1.2(11)	C(52)	C(47)	C(48)	C(49)	-62.3(11)
C(16)	C(4)	N(1)	C(1)	-121.2(11)	C(52)	C(47)	P(1)	C(41)	-169.7(6)
C(16)	C(4)	N(1)	C(2)	47.8(13)	C(52)	C(47)	P(1)	C(53)	-59.8(8)
C(16)	C(11)	C(12)	C(13)	-4.8(19)	C(52)	C(47)	P(1)	Ru(1)	71.8(7)
C(17)	C(18)	C(19)	C(20)	-2.3(14)	C(53)	C(54)	C(55)	C(56)	56.8(12)
C(18)	C(17)	C(22)	C(21)	0.5(16)	C(53)	P(1)	Ru(1)	C(1)	-116.7(8)
C(18)	C(17)	C(22)	C(25)	-178.9(10)	C(53)	P(1)	Ru(1)	C(26)	67.6(5)
C(18)	C(17)	N(2)	C(1)	94.9(14)	C(53)	P(1)	Ru(1)	Cl(1)	164.2(4)
C(18)	C(17)	N(2)	C(3)	-94.2(14)	C(53)	P(1)	Ru(1)	Cl(2)	-32.7(4)
C(18)	C(19)	C(20)	C(21)	3.0(15)	C(54)	C(53)	C(58)	C(57)	61.1(11)
C(18)	C(19)	C(20)	C(24)	-179.8(10)	C(54)	C(53)	P(1)	C(41)	-175.0(7)
C(19)	C(20)	C(21)	C(22)	-2.1(17)	C(54)	C(53)	P(1)	C(47)	75.8(9)
C(20)	C(21)	C(22)	C(17)	0.4(17)	C(54)	C(53)	P(1)	Ru(1)	-56.2(8)
C(20)	C(21)	C(22)	C(25)	179.7(11)	C(54)	C(55)	C(56)	C(57)	-52.3(14)
C(22)	C(17)	C(18)	C(19)	0.4(15)	C(55)	C(56)	C(57)	C(58)	51.3(15)
C(22)	C(17)	C(18)	C(23)	179.4(10)	C(56)	C(57)	C(58)	C(53)	-55.2(13)
C(22)	C(17)	N(2)	C(1)	-90.6(14)	C(58)	C(53)	C(54)	C(55)	-61.9(11)
C(22)	C(17)	N(2)	C(3)	80.4(14)	C(58)	C(53)	P(1)	C(41)	54.3(8)
C(23)	C(18)	C(19)	C(20)	178.8(10)	C(58)	C(53)	P(1)	C(47)	-55.0(9)
C(24)	C(20)	C(21)	C(22)	-179.3(11)	C(58)	C(53)	P(1)	Ru(1)	173.1(6)
C(26)	C(27)	C(28)	C(29)	2.2(11)	N(1)	C(1)	N(2)	C(3)	-0.8(14)

C(26)	C(27)	C(28)	C(35)	177.7(8)	N(1)	C(1)	N(2)	C(17)	170.6(11)
C(27)	C(26)	C(34)	C(29)	0.6(9)	N(1)	C(1)	Ru(1)	C(26)	-177.1(8)
C(27)	C(26)	C(34)	C(33)	-178.9(12)	N(1)	C(1)	Ru(1)	Cl(1)	86.8(8)
C(27)	C(26)	Ru(1)	C(1)	-95.4(7)	N(1)	C(1)	Ru(1)	Cl(2)	-76.4(8)
C(27)	C(26)	Ru(1)	Cl(1)	-7.6(7)	N(1)	C(1)	Ru(1)	P(1)	7.1(14)
C(27)	C(26)	Ru(1)	Cl(2)	172.7(6)	N(1)	C(2)	C(3)	N(2)	5.6(15)
C(27)	C(26)	Ru(1)	P(1)	82.8(7)	N(1)	C(4)	C(5)	C(6)	-59.2(16)
C(27)	C(28)	C(29)	C(30)	178.7(10)	N(1)	C(4)	C(5)	C(10)	122.1(10)
C(27)	C(28)	C(29)	C(34)	-1.8(12)	N(1)	C(4)	C(16)	C(11)	-120.0(10)
C(27)	C(28)	C(35)	C(36)	-35.9(14)	N(1)	C(4)	C(16)	C(15)	54.6(14)
C(27)	C(28)	C(35)	C(40)	146.8(10)	N(2)	C(1)	N(1)	C(2)	4.9(13)
C(28)	C(29)	C(30)	C(31)	-177.3(11)	N(2)	C(1)	N(1)	C(4)	174.5(10)
C(28)	C(29)	C(34)	C(26)	0.7(10)	N(2)	C(1)	Ru(1)	C(26)	1.8(11)
C(28)	C(29)	C(34)	C(33)	-179.8(10)	N(2)	C(1)	Ru(1)	Cl(1)	-94.3(10)
C(28)	C(35)	C(36)	C(37)	-176.1(9)	N(2)	C(1)	Ru(1)	Cl(2)	102.5(10)
C(28)	C(35)	C(40)	C(39)	175.5(10)	N(2)	C(1)	Ru(1)	P(1)	-173.9(6)
C(29)	C(28)	C(35)	C(36)	138.9(10)	N(2)	C(17)	C(18)	C(19)	174.8(8)
C(29)	C(28)	C(35)	C(40)	-38.5(14)	N(2)	C(17)	C(18)	C(23)	-6.3(15)
C(29)	C(30)	C(31)	C(32)	-6.5(18)	N(2)	C(17)	C(22)	C(21)	-174.0(9)
C(30)	C(29)	C(34)	C(26)	-179.8(8)	N(2)	C(17)	C(22)	C(25)	6.7(15)
C(30)	C(29)	C(34)	C(33)	-0.2(14)	P(1)	C(41)	C(42)	C(43)	179.0(8)
C(30)	C(31)	C(32)	C(33)	6(2)	P(1)	C(41)	C(46)	C(45)	175.6(8)
C(31)	C(32)	C(33)	C(34)	-3.1(19)	P(1)	C(47)	C(48)	C(49)	168.2(8)
C(32)	C(33)	C(34)	C(26)	179.6(11)	P(1)	C(47)	C(52)	C(51)	-163.1(7)
C(32)	C(33)	C(34)	C(29)	0.2(17)	P(1)	C(53)	C(54)	C(55)	163.7(7)
C(34)	C(26)	C(27)	C(28)	-1.8(10)	P(1)	C(53)	C(58)	C(57)	-165.7(7)
C(34)	C(26)	Ru(1)	C(1)	85.8(8)	Ru(1)	C(1)	N(1)	C(2)	-176.0(8)
C(34)	C(26)	Ru(1)	Cl(1)	173.6(8)	Ru(1)	C(1)	N(1)	C(4)	-6.4(15)
C(34)	C(26)	Ru(1)	Cl(2)	-6.1(8)	Ru(1)	C(1)	N(2)	C(3)	-179.8(10)
C(34)	C(26)	Ru(1)	P(1)	-96.0(8)	Ru(1)	C(1)	N(2)	C(17)	-8.4(18)
C(34)	C(29)	C(30)	C(31)	3.3(15)	Ru(1)	C(26)	C(27)	C(28)	179.1(6)
C(35)	C(28)	C(29)	C(30)	3.2(18)	Ru(1)	C(26)	C(34)	C(29)	179.6(6)
C(35)	C(28)	C(29)	C(34)	-177.3(8)	Ru(1)	C(26)	C(34)	C(33)	0.1(17)

Table S10. Bond lengths for **Ru10**.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C(1)	N(1)	1.345(6)	C(35)	C(34)	1.390(7)
C(1)	N(2)	1.343(6)	C(35)	C(30)	1.422(7)
C(1)	Ru(1)	2.082(4)	C(34)	C(33)	1.385(9)
C(2)	C(3)	1.506(8)	C(33)	C(32)	1.369(9)
C(2)	N(1)	1.468(7)	C(32)	C(31)	1.407(8)
C(3)	N(2)	1.486(7)	C(31)	C(30)	1.380(8)
C(4)	C(5)	1.525(7)	C(38)	C(43)	1.392(8)
C(4)	C(16)	1.523(7)	C(38)	C(39)	1.404(7)
C(4)	N(1)	1.455(6)	C(43)	C(42)	1.376(8)
C(5)	C(6)	1.367(8)	C(42)	C(41)	1.392(8)
C(5)	C(10)	1.403(7)	C(41)	C(40)	1.390(8)
C(6)	C(7)	1.392(7)	C(40)	C(39)	1.381(8)
C(7)	C(8)	1.386(8)	C(50)	C(51)	1.525(7)
C(8)	C(9)	1.382(8)	C(50)	C(55)	1.542(7)
C(9)	C(10)	1.386(7)	C(50)	P(1)	1.854(5)
C(10)	C(11)	1.460(8)	C(51)	C(52)	1.532(8)
C(11)	C(12)	1.385(8)	C(52)	C(53)	1.530(10)
C(11)	C(16)	1.407(7)	C(53)	C(54)	1.509(9)

C(12)	C(13)	1.388(8)	C(54)	C(55)	1.527(8)
C(13)	C(14)	1.378(9)	C(44)	C(45)	1.539(7)
C(14)	C(15)	1.385(8)	C(44)	C(49)	1.540(7)
C(15)	C(16)	1.381(8)	C(44)	P(1)	1.862(5)
C(17)	C(18)	1.405(7)	C(45)	C(46)	1.523(7)
C(17)	C(22)	1.403(7)	C(46)	C(47)	1.514(8)
C(17)	N(2)	1.441(6)	C(47)	C(48)	1.519(8)
C(18)	C(19)	1.392(7)	C(48)	C(49)	1.525(7)
C(18)	C(23)	1.516(7)	C(56)	C(61)	1.528(7)
C(19)	C(20)	1.378(7)	C(56)	C(57)	1.533(7)
C(20)	C(21)	1.380(7)	C(56)	P(1)	1.871(5)
C(21)	C(22)	1.392(7)	C(61)	C(60)	1.531(7)
C(22)	C(26)	1.529(7)	C(60)	C(59)	1.517(8)
C(23)	C(24)	1.515(8)	C(59)	C(58)	1.521(7)
C(23)	C(25)	1.536(9)	C(58)	C(57)	1.536(7)
C(26)	C(27)	1.522(8)	Cl(1)	Ru(1)	2.3965(13)
C(26)	C(28)	1.554(8)	Cl(2)	Ru(1)	2.4120(12)
C(29)	C(37)	1.457(8)	P(1)	Ru(1)	2.4228(13)
C(29)	C(30)	1.507(7)	C(62)	C(63)	1.491(10)
C(29)	Ru(1)	1.872(5)	C(62)	O(1)	1.414(8)
C(37)	C(36)	1.354(7)	C(64)	C(65)	1.455(10)
C(36)	C(35)	1.469(8)	C(64)	O(1)	1.421(8)
C(36)	C(38)	1.475(8)			

Table S11. Values of valence angles for **Ru10**.

Atom	**Atom**	**Atom**	**Angle/°**	**Atom**	**Atom**	**Atom**	**Angle/°**
N(1)	C(1)	Ru(1)	118.6(3)	C(35)	C(30)	C(29)	106.4(5)
N(2)	C(1)	N(1)	107.8(4)	C(31)	C(30)	C(29)	133.8(5)
N(2)	C(1)	Ru(1)	133.3(3)	C(31)	C(30)	C(35)	119.7(5)
N(1)	C(2)	C(3)	101.6(4)	C(43)	C(38)	C(36)	119.8(5)
N(2)	C(3)	C(2)	102.8(4)	C(43)	C(38)	C(39)	118.6(5)
C(16)	C(4)	C(5)	102.9(4)	C(39)	C(38)	C(36)	121.5(5)
N(1)	C(4)	C(5)	113.1(5)	C(42)	C(43)	C(38)	120.6(5)
N(1)	C(4)	C(16)	115.3(4)	C(43)	C(42)	C(41)	120.7(6)
C(6)	C(5)	C(4)	128.6(4)	C(40)	C(41)	C(42)	119.2(6)
C(6)	C(5)	C(10)	122.0(5)	C(39)	C(40)	C(41)	120.3(5)
C(10)	C(5)	C(4)	109.4(5)	C(40)	C(39)	C(38)	120.6(6)
C(5)	C(6)	C(7)	118.4(5)	C(51)	C(50)	C(55)	110.2(4)
C(8)	C(7)	C(6)	120.5(5)	C(51)	C(50)	P(1)	115.1(4)
C(9)	C(8)	C(7)	120.7(5)	C(55)	C(50)	P(1)	115.5(4)
C(8)	C(9)	C(10)	119.5(5)	C(50)	C(51)	C(52)	109.0(4)
C(5)	C(10)	C(11)	109.2(4)	C(53)	C(52)	C(51)	111.7(5)
C(9)	C(10)	C(5)	118.9(5)	C(54)	C(53)	C(52)	110.7(5)
C(9)	C(10)	C(11)	131.9(5)	C(53)	C(54)	C(55)	112.4(5)
C(12)	C(11)	C(10)	131.3(5)	C(54)	C(55)	C(50)	111.2(5)
C(12)	C(11)	C(16)	119.5(5)	C(45)	C(44)	C(49)	108.8(4)
C(16)	C(11)	C(10)	109.2(4)	C(45)	C(44)	P(1)	112.2(3)
C(11)	C(12)	C(13)	119.3(6)	C(49)	C(44)	P(1)	117.3(3)
C(14)	C(13)	C(12)	120.6(6)	C(46)	C(45)	C(44)	111.8(4)
C(13)	C(14)	C(15)	121.0(6)	C(47)	C(46)	C(45)	110.7(4)
C(16)	C(15)	C(14)	118.7(5)	C(46)	C(47)	C(48)	110.7(5)
C(11)	C(16)	C(4)	109.2(4)	C(47)	C(48)	C(49)	111.6(5)
C(15)	C(16)	C(4)	129.9(5)	C(48)	C(49)	C(44)	110.0(4)
C(15)	C(16)	C(11)	120.9(5)	C(61)	C(56)	C(57)	110.8(4)

C(18)	C(17)	N(2)	117.9(4)	C(61)	C(56)	P(1)	112.3(3)
C(22)	C(17)	C(18)	122.6(4)	C(57)	C(56)	P(1)	112.4(3)
C(22)	C(17)	N(2)	119.5(4)	C(56)	C(61)	C(60)	111.7(4)
C(17)	C(18)	C(23)	122.3(4)	C(59)	C(60)	C(61)	111.7(5)
C(19)	C(18)	C(17)	116.9(5)	C(60)	C(59)	C(58)	110.3(5)
C(19)	C(18)	C(23)	120.8(4)	C(59)	C(58)	C(57)	111.2(4)
C(20)	C(19)	C(18)	121.6(5)	C(56)	C(57)	C(58)	111.4(4)
C(19)	C(20)	C(21)	120.3(5)	C(1)	N(1)	C(2)	113.2(4)
C(20)	C(21)	C(22)	120.9(5)	C(1)	N(1)	C(4)	125.9(4)
C(17)	C(22)	C(26)	122.3(5)	C(4)	N(1)	C(2)	120.9(4)
C(21)	C(22)	C(17)	117.6(5)	C(1)	N(2)	C(3)	111.4(4)
C(21)	C(22)	C(26)	119.9(5)	C(1)	N(2)	C(17)	127.4(4)
C(18)	C(23)	C(25)	110.5(5)	C(17)	N(2)	C(3)	121.1(4)
C(24)	C(23)	C(18)	114.0(5)	C(50)	P(1)	C(44)	110.0(2)
C(24)	C(23)	C(25)	108.7(5)	C(50)	P(1)	C(56)	101.3(2)
C(22)	C(26)	C(28)	109.0(4)	C(50)	P(1)	Ru(1)	115.26(17)
C(27)	C(26)	C(22)	114.3(5)	C(44)	P(1)	C(56)	104.6(2)
C(27)	C(26)	C(28)	107.9(5)	C(44)	P(1)	Ru(1)	114.56(16)
C(37)	C(29)	C(30)	104.8(4)	C(56)	P(1)	Ru(1)	109.72(17)
C(37)	C(29)	Ru(1)	122.2(4)	C(1)	Ru(1)	Cl(1)	88.81(13)
C(30)	C(29)	Ru(1)	133.0(4)	C(1)	Ru(1)	Cl(2)	84.60(13)
C(36)	C(37)	C(29)	112.0(5)	C(1)	Ru(1)	P(1)	157.63(13)
C(37)	C(36)	C(35)	107.7(5)	C(29)	Ru(1)	C(1)	104.70(19)
C(37)	C(36)	C(38)	124.4(5)	C(29)	Ru(1)	Cl(1)	98.56(17)
C(35)	C(36)	C(38)	128.0(5)	C(29)	Ru(1)	Cl(2)	97.69(17)
C(34)	C(35)	C(36)	130.8(5)	C(29)	Ru(1)	P(1)	97.47(15)
C(34)	C(35)	C(30)	119.9(6)	Cl(1)	Ru(1)	Cl(2)	163.55(4)
C(30)	C(35)	C(36)	109.2(4)	Cl(1)	Ru(1)	P(1)	90.82(4)
C(33)	C(34)	C(35)	119.4(6)	Cl(2)	Ru(1)	P(1)	89.61(4)
C(32)	C(33)	C(34)	121.1(5)	O(1)	C(62)	C(63)	108.3(6)
C(33)	C(32)	C(31)	120.5(6)	O(1)	C(64)	C(65)	111.6(7)
C(30)	C(31)	C(32)	119.4(6)	C(62)	O(1)	C(64)	112.4(5)

Table S12. Values of torsion angles for **Ru10**.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
C(2)	C(3)	N(2)	C(1)	-15.7(6)	C(34)	C(33)	C(32)	C(31)	-0.8(9)
C(2)	C(3)	N(2)	C(17)	162.5(4)	C(33)	C(32)	C(31)	C(30)	1.3(9)
C(3)	C(2)	N(1)	C(1)	-14.6(6)	C(32)	C(31)	C(30)	C(29)	-176.2(5)
C(3)	C(2)	N(1)	C(4)	166.1(5)	C(32)	C(31)	C(30)	C(35)	-1.2(8)
C(4)	C(5)	C(6)	C(7)	-178.9(5)	C(30)	C(29)	C(37)	C(36)	0.2(6)
C(4)	C(5)	C(10)	C(9)	179.8(5)	C(30)	C(29)	Ru(1)	C(1)	-103.6(5)
C(4)	C(5)	C(10)	C(11)	-1.5(6)	C(30)	C(29)	Ru(1)	Cl(1)	-12.6(5)
C(5)	C(4)	C(16)	C(11)	-2.8(6)	C(30)	C(29)	Ru(1)	Cl(2)	170.0(4)
C(5)	C(4)	C(16)	C(15)	179.6(6)	C(30)	C(29)	Ru(1)	P(1)	79.4(5)
C(5)	C(4)	N(1)	C(1)	121.1(5)	C(30)	C(35)	C(34)	C(33)	0.0(8)
C(5)	C(4)	N(1)	C(2)	-59.8(6)	C(38)	C(36)	C(35)	C(34)	4.8(9)
C(5)	C(6)	C(7)	C(8)	-0.1(9)	C(38)	C(36)	C(35)	C(30)	-178.7(5)
C(5)	C(10)	C(11)	C(12)	178.0(6)	C(38)	C(43)	C(42)	C(41)	0.2(9)
C(5)	C(10)	C(11)	C(16)	-0.4(6)	C(43)	C(38)	C(39)	C(40)	-1.7(9)
C(6)	C(5)	C(10)	C(9)	1.6(8)	C(43)	C(42)	C(41)	C(40)	-0.7(9)
C(6)	C(5)	C(10)	C(11)	-179.7(5)	C(42)	C(41)	C(40)	C(39)	0.0(9)
C(6)	C(7)	C(8)	C(9)	0.6(9)	C(41)	C(40)	C(39)	C(38)	1.2(9)
C(7)	C(8)	C(9)	C(10)	0.0(9)	C(39)	C(38)	C(43)	C(42)	1.0(8)
C(8)	C(9)	C(10)	C(5)	-1.0(8)	C(50)	C(51)	C(52)	C(53)	59.3(6)

C(8) C(9) C(10) C(11)	-179.4(6)	C(51) C(50) C(55) C(54)	56.5(6)
C(9) C(10) C(11) C(12)	-3.5(10)	C(51) C(50) P(1) C(44)	76.5(4)
C(9) C(10) C(11) C(16)	178.2(6)	C(51) C(50) P(1) C(56)	-173.1(4)
C(10) C(5) C(6) C(7)	-1.0(8)	C(51) C(50) P(1) Ru(1)	-54.8(4)
C(10) C(11) C(12) C(13)	-179.0(6)	C(51) C(52) C(53) C(54)	-56.4(7)
C(10) C(11) C(16) C(4)	2.0(6)	C(52) C(53) C(54) C(55)	53.3(7)
C(10) C(11) C(16) C(15)	179.9(5)	C(53) C(54) C(55) C(50)	-53.9(7)
C(11) C(12) C(13) C(14)	-0.5(9)	C(55) C(50) C(51) C(52)	-58.7(6)
C(12) C(11) C(16) C(4)	-176.6(5)	C(55) C(50) P(1) C(44)	-53.8(4)
C(12) C(11) C(16) C(15)	1.3(8)	C(55) C(50) P(1) C(56)	56.5(4)
C(12) C(13) C(14) C(15)	1.2(10)	C(55) C(50) P(1) Ru(1)	174.9(3)
C(13) C(14) C(15) C(16)	-0.7(10)	C(44) C(45) C(46) C(47)	-56.9(6)
C(14) C(15) C(16) C(4)	176.8(6)	C(45) C(44) C(49) C(48)	-57.4(6)
C(14) C(15) C(16) C(11)	-0.6(9)	C(45) C(44) P(1) C(50)	-47.2(4)
C(16) C(4) C(5) C(6)	-179.4(5)	C(45) C(44) P(1) C(56)	-155.3(4)
C(16) C(4) C(5) C(10)	2.5(6)	C(45) C(44) P(1) Ru(1)	84.5(3)
C(16) C(4) N(1) C(1)	-120.8(5)	C(45) C(46) C(47) C(48)	55.5(6)
C(16) C(4) N(1) C(2)	58.4(6)	C(46) C(47) C(48) C(49)	-57.0(6)
C(16) C(11) C(12) C(13)	-0.8(8)	C(47) C(48) C(49) C(44)	58.2(6)
C(17) C(18) C(19) C(20)	-1.0(7)	C(49) C(44) C(45) C(46)	57.4(6)
C(17) C(18) C(23) C(24)	-154.5(5)	C(49) C(44) P(1) C(50)	79.8(4)
C(17) C(18) C(23) C(25)	82.7(6)	C(49) C(44) P(1) C(56)	-28.3(4)
C(17) C(22) C(26) C(27)	139.8(5)	C(49) C(44) P(1) Ru(1)	-148.5(3)
C(17) C(22) C(26) C(28)	-99.4(6)	C(56) C(61) C(60) C(59)	55.4(7)
C(18) C(17) C(22) C(21)	-1.6(7)	C(61) C(56) C(57) C(58)	54.1(6)
C(18) C(17) C(22) C(26)	174.2(4)	C(61) C(56) P(1) C(50)	178.7(4)
C(18) C(17) N(2) C(1)	76.7(6)	C(61) C(56) P(1) C(44)	-67.0(4)
C(18) C(17) N(2) C(3)	-101.1(6)	C(61) C(56) P(1) Ru(1)	56.4(4)
C(18) C(19) C(20) C(21)	-0.7(8)	C(61) C(60) C(59) C(58)	-56.6(6)
C(19) C(18) C(23) C(24)	28.4(7)	C(60) C(59) C(58) C(57)	57.1(6)
C(19) C(18) C(23) C(25)	-94.4(6)	C(59) C(58) C(57) C(56)	-56.3(6)
C(19) C(20) C(21) C(22)	1.2(8)	C(57) C(56) C(61) C(60)	-53.5(6)
C(20) C(21) C(22) C(17)	-0.1(7)	C(57) C(56) P(1) C(50)	52.8(4)
C(20) C(21) C(22) C(26)	-176.1(5)	C(57) C(56) P(1) C(44)	167.2(4)
C(21) C(22) C(26) C(27)	-44.5(7)	C(57) C(56) P(1) Ru(1)	-69.4(4)
C(21) C(22) C(26) C(28)	76.3(6)	N(1) C(1) N(2) C(3)	7.0(6)
C(22) C(17) C(18) C(19)	2.1(7)	N(1) C(1) N(2) C(17)	-171.0(4)
C(22) C(17) C(18) C(23)	-175.1(5)	N(1) C(2) C(3) N(2)	16.8(6)
C(22) C(17) N(2) C(1)	-106.3(6)	N(1) C(4) C(5) C(6)	-54.3(7)
C(22) C(17) N(2) C(3)	75.8(6)	N(1) C(4) C(5) C(10)	127.7(5)
C(23) C(18) C(19) C(20)	176.3(5)	N(1) C(4) C(16) C(11)	-126.4(5)
C(29) C(37) C(36) C(35)	-0.3(6)	N(1) C(4) C(16) C(15)	56.0(8)
C(29) C(37) C(36) C(38)	178.7(5)	N(2) C(1) N(1) C(2)	5.3(6)
C(37) C(29) C(30) C(35)	-0.1(5)	N(2) C(1) N(1) C(4)	-175.5(4)
C(37) C(29) C(30) C(31)	175.4(6)	N(2) C(17) C(18) C(19)	179.0(4)
C(37) C(29) Ru(1) C(1)	77.6(4)	N(2) C(17) C(18) C(23)	1.8(7)
C(37) C(29) Ru(1) Cl(1)	168.6(4)	N(2) C(17) C(22) C(21)	-178.4(4)
C(37) C(29) Ru(1) Cl(2)	-8.8(4)	N(2) C(17) C(22) C(26)	-2.6(7)
C(37) C(29) Ru(1) P(1)	-99.4(4)	P(1) C(50) C(51) C(52)	168.5(4)
C(37) C(36) C(35) C(34)	-176.2(6)	P(1) C(50) C(55) C(54)	-170.9(4)
C(37) C(36) C(35) C(30)	0.2(6)	P(1) C(44) C(45) C(46)	-171.2(4)
C(37) C(36) C(38) C(43)	36.7(8)	P(1) C(44) C(49) C(48)	174.0(4)
C(37) C(36) C(38) C(39)	-139.5(6)	P(1) C(56) C(61) C(60)	179.8(4)
C(36) C(35) C(34) C(33)	176.2(5)	P(1) C(56) C(57) C(58)	-179.2(4)

C(36)	C(35)	C(30)	C(29)	-0.1(6)	Ru(1)	C(1)	N(1)	C(2)	-180.0(4)
C(36)	C(35)	C(30)	C(31)	-176.4(5)	Ru(1)	C(1)	N(1)	C(4)	-0.8(6)
C(36)	C(38)	C(43)	C(42)	-175.3(5)	Ru(1)	C(1)	N(2)	C(3)	-166.6(4)
C(36)	C(38)	C(39)	C(40)	174.5(5)	Ru(1)	C(1)	N(2)	C(17)	15.3(8)
C(35)	C(36)	C(38)	C(43)	-144.5(6)	Ru(1)	C(29)	C(37)	C(36)	179.3(4)
C(35)	C(36)	C(38)	C(39)	39.3(8)	Ru(1)	C(29)	C(30)	C(35)	-179.0(4)
C(35)	C(34)	C(33)	C(32)	0.1(9)	Ru(1)	C(29)	C(30)	C(31)	-3.5(9)
C(34)	C(35)	C(30)	C(29)	176.8(5)	C(63)	C(62)	O(1)	C(64)	179.3(6)
C(34)	C(35)	C(30)	C(31)	0.6(8)	C(65)	C(64)	O(1)	C(62)	163.3(6)

Table S13. Bond lengths for **Ru11**.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C(1A)	N(1A)	1.337(8)	C(1B)	N(1B)	1.364(9)
C(1A)	N(2A)	1.372(8)	C(1B)	N(2B)	1.361(8)
C(1A)	Ru(1A)	1.974(7)	C(1B)	Ru(1B)	1.958(7)
C(2A)	C(3A)	1.508(9)	C(2B)	C(3B)	1.510(10)
C(2A)	N(1A)	1.472(8)	C(2B)	N(1B)	1.460(9)
C(3A)	N(2A)	1.474(9)	C(3B)	N(2B)	1.470(9)
C(4A)	C(5A)	1.526(9)	C(4B)	C(5B)	1.517(9)
C(4A)	C(16A)	1.525(8)	C(4B)	C(16B)	1.532(8)
C(4A)	N(1A)	1.455(7)	C(4B)	N(1B)	1.462(8)
C(5A)	C(6A)	1.387(10)	C(5B)	C(6B)	1.392(9)
C(5A)	C(10A)	1.412(10)	C(5B)	C(10B)	1.399(10)
C(6A)	C(7A)	1.397(11)	C(6B)	C(7B)	1.389(10)
C(7A)	C(8A)	1.386(11)	C(7B)	C(8B)	1.397(11)
C(8A)	C(9A)	1.405(11)	C(8B)	C(9B)	1.400(10)
C(9A)	C(10A)	1.387(11)	C(9B)	C(10B)	1.383(10)
C(10A)	C(11A)	1.466(10)	C(10B)	C(11B)	1.487(9)
C(11A)	C(12A)	1.403(9)	C(11B)	C(12B)	1.402(9)
C(11A)	C(16A)	1.402(10)	C(11B)	C(16B)	1.389(10)
C(12A)	C(13A)	1.396(10)	C(12B)	C(13B)	1.380(10)
C(13A)	C(14A)	1.398(11)	C(13B)	C(14B)	1.394(11)
C(14A)	C(15A)	1.402(9)	C(14B)	C(15B)	1.390(9)
C(15A)	C(16A)	1.376(10)	C(15B)	C(16B)	1.389(9)
C(17A)	C(18A)	1.401(10)	C(17B)	C(18B)	1.378(10)
C(17A)	C(22A)	1.397(9)	C(17B)	C(22B)	1.401(9)
C(17A)	N(2A)	1.423(8)	C(17B)	N(2B)	1.430(9)
C(18A)	C(19A)	1.393(10)	C(18B)	C(19B)	1.393(10)
C(18A)	C(23A)	1.516(8)	C(18B)	C(23B)	1.517(9)
C(19A)	C(20A)	1.387(10)	C(19B)	C(20B)	1.393(10)
C(20A)	C(21A)	1.394(10)	C(20B)	C(21B)	1.391(10)
C(20A)	C(24A)	1.506(9)	C(20B)	C(24B)	1.509(9)
C(21A)	C(22A)	1.390(9)	C(21B)	C(22B)	1.397(10)
C(22A)	C(25A)	1.515(9)	C(22B)	C(25B)	1.495(9)
C(26A)	C(27A)	1.419(9)	C(26B)	C(27B)	1.402(9)
C(26A)	C(31A)	1.383(10)	C(26B)	C(31B)	1.409(10)
C(26A)	O(1A)	1.367(8)	C(26B)	O(1B)	1.367(8)
C(27A)	C(28A)	1.400(9)	C(27B)	C(28B)	1.402(9)
C(27A)	C(32A)	1.439(10)	C(27B)	C(32B)	1.452(9)

C(28A)	C(29A)	1.383(10)	C(28B)	C(29B)	1.391(10)
C(29A)	C(30A)	1.398(9)	C(29B)	C(30B)	1.391(10)
C(30A)	C(31A)	1.382(10)	C(30B)	C(31B)	1.375(9)
C(32A)	Ru(1A)	1.850(7)	C(32B)	Ru(1B)	1.819(7)
C(33A)	C(34A)	1.499(10)	C(33B)	C(34B)	1.513(9)
C(33A)	C(35A)	1.511(10)	C(33B)	C(35B)	1.498(10)
C(33A)	O(1A)	1.480(8)	C(33B)	O(1B)	1.478(7)
Cl(1A)	Ru(1A)	2.3245(15)	Cl(1B)	Ru(1B)	2.3203(15)
Cl(2A)	Ru(1A)	2.3312(15)	Cl(2B)	Ru(1B)	2.3357(16)
O(1A)	Ru(1A)	2.274(5)	O(1B)	Ru(1B)	2.277(5)

Table S14. Values of valence angles for **Ru11**.

Atom	**Atom**	**Atom**	**Angle/°**	**Atom**	**Atom**	**Atom**	**Angle/°**
N(1A)	C(1A)	N(2A)	106.5(6)	N(1B)	C(1B)	Ru(1B)	120.8(5)
N(1A)	C(1A)	Ru(1A)	121.0(4)	N(2B)	C(1B)	N(1B)	105.9(6)
N(2A)	C(1A)	Ru(1A)	131.9(5)	N(2B)	C(1B)	Ru(1B)	133.1(5)
N(1A)	C(2A)	C(3A)	103.0(6)	N(1B)	C(2B)	C(3B)	102.6(6)
N(2A)	C(3A)	C(2A)	102.7(5)	N(2B)	C(3B)	C(2B)	103.5(6)
C(16A)	C(4A)	C(5A)	102.5(5)	C(5B)	C(4B)	C(16B)	101.7(5)
N(1A)	C(4A)	C(5A)	113.0(5)	N(1B)	C(4B)	C(5B)	113.2(5)
N(1A)	C(4A)	C(16A)	112.2(5)	N(1B)	C(4B)	C(16B)	112.1(5)
C(6A)	C(5A)	C(4A)	129.7(6)	C(6B)	C(5B)	C(4B)	128.6(6)
C(6A)	C(5A)	C(10A)	120.4(7)	C(6B)	C(5B)	C(10B)	120.4(7)
C(10A)	C(5A)	C(4A)	110.0(6)	C(10B)	C(5B)	C(4B)	111.0(6)
C(5A)	C(6A)	C(7A)	119.3(7)	C(7B)	C(6B)	C(5B)	118.6(7)
C(8A)	C(7A)	C(6A)	120.4(7)	C(6B)	C(7B)	C(8B)	120.8(6)
C(7A)	C(8A)	C(9A)	120.7(7)	C(7B)	C(8B)	C(9B)	120.6(7)
C(10A)	C(9A)	C(8A)	119.0(7)	C(10B)	C(9B)	C(8B)	118.3(7)
C(5A)	C(10A)	C(11A)	108.2(7)	C(5B)	C(10B)	C(11B)	108.0(6)
C(9A)	C(10A)	C(5A)	120.2(7)	C(9B)	C(10B)	C(5B)	121.3(6)
C(9A)	C(10A)	C(11A)	131.6(7)	C(9B)	C(10B)	C(11B)	130.6(7)
C(12A)	C(11A)	C(10A)	130.5(7)	C(12B)	C(11B)	C(10B)	130.3(7)
C(16A)	C(11A)	C(10A)	109.6(6)	C(16B)	C(11B)	C(10B)	108.6(6)
C(16A)	C(11A)	C(12A)	119.9(6)	C(16B)	C(11B)	C(12B)	121.1(7)
C(13A)	C(12A)	C(11A)	118.3(7)	C(13B)	C(12B)	C(11B)	117.7(7)
C(12A)	C(13A)	C(14A)	121.0(6)	C(12B)	C(13B)	C(14B)	121.7(6)
C(13A)	C(14A)	C(15A)	120.5(7)	C(15B)	C(14B)	C(13B)	120.0(7)
C(16A)	C(15A)	C(14A)	118.3(7)	C(16B)	C(15B)	C(14B)	119.0(7)
C(11A)	C(16A)	C(4A)	109.6(6)	C(11B)	C(16B)	C(4B)	110.6(6)
C(15A)	C(16A)	C(4A)	128.4(6)	C(11B)	C(16B)	C(15B)	120.4(6)
C(15A)	C(16A)	C(11A)	121.9(6)	C(15B)	C(16B)	C(4B)	129.0(6)
C(18A)	C(17A)	N(2A)	120.4(6)	C(18B)	C(17B)	C(22B)	121.0(7)
C(22A)	C(17A)	C(18A)	121.1(6)	C(18B)	C(17B)	N(2B)	120.5(6)
C(22A)	C(17A)	N(2A)	118.5(6)	C(22B)	C(17B)	N(2B)	118.4(6)
C(17A)	C(18A)	C(23A)	120.5(6)	C(17B)	C(18B)	C(19B)	119.4(6)

C(19A)	C(18A)	C(17A)	117.9(6)	C(17B) C(18B) C(23B)	121.3(6)
C(19A)	C(18A)	C(23A)	121.6(6)	C(19B) C(18B) C(23B)	119.3(6)
C(20A)	C(19A)	C(18A)	122.3(6)	C(20B) C(19B) C(18B)	121.1(6)
C(19A)	C(20A)	C(21A)	118.2(6)	C(19B) C(20B) C(24B)	121.5(7)
C(19A)	C(20A)	C(24A)	121.0(6)	C(21B) C(20B) C(19B)	118.6(6)
C(21A)	C(20A)	C(24A)	120.8(6)	C(21B) C(20B) C(24B)	119.9(6)
C(22A)	C(21A)	C(20A)	121.5(6)	C(20B) C(21B) C(22B)	121.2(6)
C(17A)	C(22A)	C(25A)	119.4(6)	C(17B) C(22B) C(25B)	120.7(7)
C(21A)	C(22A)	C(17A)	118.7(6)	C(21B) C(22B) C(17B)	118.6(6)
C(21A)	C(22A)	C(25A)	121.9(6)	C(21B) C(22B) C(25B)	120.7(6)
C(31A)	C(26A)	C(27A)	121.0(6)	C(27B) C(26B) C(31B)	121.1(6)
O(1A)	C(26A)	C(27A)	112.4(6)	O(1B) C(26B) C(27B)	113.8(6)
O(1A)	C(26A)	C(31A)	126.6(6)	O(1B) C(26B) C(31B)	125.1(6)
C(26A)	C(27A)	C(32A)	119.2(6)	C(26B) C(27B) C(32B)	118.2(6)
C(28A)	C(27A)	C(26A)	118.2(6)	C(28B) C(27B) C(26B)	118.2(6)
C(28A)	C(27A)	C(32A)	122.6(6)	C(28B) C(27B) C(32B)	123.6(6)
C(29A)	C(28A)	C(27A)	120.4(6)	C(29B) C(28B) C(27B)	121.6(6)
C(28A)	C(29A)	C(30A)	120.3(6)	C(28B) C(29B) C(30B)	118.3(6)
C(31A)	C(30A)	C(29A)	120.3(6)	C(31B) C(30B) C(29B)	122.6(7)
C(30A)	C(31A)	C(26A)	119.6(6)	C(30B) C(31B) C(26B)	118.2(6)
C(27A)	C(32A)	Ru(1A)	118.5(5)	C(27B) C(32B) Ru(1B)	119.0(5)
C(34A)	C(33A)	C(35A)	114.1(6)	C(35B) C(33B) C(34B)	114.2(6)
O(1A)	C(33A)	C(34A)	110.2(5)	O(1B) C(33B) C(34B)	108.9(5)
O(1A)	C(33A)	C(35A)	106.1(5)	O(1B) C(33B) C(35B)	105.9(5)
C(1A)	N(1A)	C(2A)	114.1(5)	C(1B) N(1B) C(2B)	114.4(6)
C(1A)	N(1A)	C(4A)	127.8(5)	C(1B) N(1B) C(4B)	126.0(5)
C(4A)	N(1A)	C(2A)	118.1(5)	C(2B) N(1B) C(4B)	119.5(6)
C(1A)	N(2A)	C(3A)	113.1(5)	C(1B) N(2B) C(3B)	113.3(6)
C(1A)	N(2A)	C(17A)	127.3(6)	C(1B) N(2B) C(17B)	129.6(6)
C(17A)	N(2A)	C(3A)	119.5(5)	C(17B) N(2B) C(3B)	116.9(5)
C(26A)	O(1A)	C(33A)	119.1(5)	C(26B) O(1B) C(33B)	120.4(5)
C(26A)	O(1A)	Ru(1A)	110.8(4)	C(26B) O(1B) Ru(1B)	109.4(4)
C(33A)	O(1A)	Ru(1A)	128.9(4)	C(33B) O(1B) Ru(1B)	129.2(4)
C(1A)	Ru(1A)	Cl(1A)	87.74(18)	C(1B) Ru(1B) Cl(1B)	89.90(18)
C(1A)	Ru(1A)	Cl(2A)	95.37(19)	C(1B) Ru(1B) Cl(2B)	94.51(18)
C(1A)	Ru(1A)	O(1A)	176.5(2)	C(1B) Ru(1B) O(1B)	178.8(2)
C(32A)	Ru(1A)	C(1A)	102.2(3)	C(32B) Ru(1B) C(1B)	99.9(3)
C(32A)	Ru(1A)	Cl(1A)	108.0(2)	C(32B) Ru(1B) Cl(1B)	107.7(2)
C(32A)	Ru(1A)	Cl(2A)	99.55(19)	C(32B) Ru(1B) Cl(2B)	101.1(2)
C(32A)	Ru(1A)	O(1A)	78.9(2)	C(32B) Ru(1B) O(1B)	79.4(3)
Cl(1A)	Ru(1A)	Cl(2A)	151.01(6)	Cl(1B) Ru(1B) Cl(2B)	149.64(6)

O(1A)	Ru(1A)	Cl(1A)	88.80(13)	O(1B)	Ru(1B)	Cl(1B)	89.34(12)		
O(1A)	Ru(1A)	Cl(2A)	87.61(13)	O(1B)	Ru(1B)	Cl(2B)	86.63(12)		

Table S15. Values of torsion angles for **Ru11**.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
C(2A)	C(3A)	N(2A)	C(1A)	6.3(8)	C(2B)	C(3B)	N(2B)	C(1B)	4.0(8)
C(2A)	C(3A)	N(2A)	C(17A)	-170.9(6)	C(2B)	C(3B)	N(2B)	C(17B)	179.4(6)
C(3A)	C(2A)	N(1A)	C(1A)	6.2(8)	C(3B)	C(2B)	N(1B)	C(1B)	3.0(8)
C(3A)	C(2A)	N(1A)	C(4A)	-172.8(6)	C(3B)	C(2B)	N(1B)	C(4B)	-174.8(6)
C(4A)	C(5A)	C(6A)	C(7A)	178.4(6)	C(4B)	C(5B)	C(6B)	C(7B)	180.0(6)
C(4A)	C(5A)	C(10A)	C(9A)	-177.0(6)	C(4B)	C(5B)	C(10B)	C(9B)	-178.8(6)
C(4A)	C(5A)	C(10A)	C(11A)	4.2(7)	C(4B)	C(5B)	C(10B)	C(11B)	3.3(7)
C(5A)	C(4A)	C(16A)	C(11A)	2.3(6)	C(5B)	C(4B)	C(16B)	C(11B)	1.4(7)
C(5A)	C(4A)	C(16A)	C(15A)	-177.6(6)	C(5B)	C(4B)	C(16B)	C(15B)	-178.1(6)
C(5A)	C(4A)	N(1A)	C(1A)	120.4(7)	C(5B)	C(4B)	N(1B)	C(1B)	125.9(7)
C(5A)	C(4A)	N(1A)	C(2A)	-60.7(7)	C(5B)	C(4B)	N(1B)	C(2B)	-56.5(8)
C(5A)	C(6A)	C(7A)	C(8A)	-0.7(10)	C(5B)	C(6B)	C(7B)	C(8B)	-1.5(10)
C(5A)	C(10A)	C(11A)	C(12A)	177.9(6)	C(5B)	C(10B)	C(11B)	C(12B)	176.3(7)
C(5A)	C(10A)	C(11A)	C(16A)	-2.7(7)	C(5B)	C(10B)	C(11B)	C(16B)	-2.3(7)
C(6A)	C(5A)	C(10A)	C(9A)	2.3(9)	C(6B)	C(5B)	C(10B)	C(9B)	1.5(10)
C(6A)	C(5A)	C(10A)	C(11A)	-176.5(6)	C(6B)	C(5B)	C(10B)	C(11B)	-176.5(6)
C(6A)	C(7A)	C(8A)	C(9A)	0.7(10)	C(6B)	C(7B)	C(8B)	C(9B)	2.3(10)
C(7A)	C(8A)	C(9A)	C(10A)	0.8(10)	C(7B)	C(8B)	C(9B)	C(10B)	-1.1(10)
C(8A)	C(9A)	C(10A)	C(5A)	-2.2(10)	C(8B)	C(9B)	C(10B)	C(5B)	-0.8(10)
C(8A)	C(9A)	C(10A)	C(11A)	176.2(7)	C(8B)	C(9B)	C(10B)	C(11B)	176.7(6)
C(9A)	C(10A)	C(11A)	C(12A)	-0.7(12)	C(9B)	C(10B)	C(11B)	C(12B)	-1.4(12)
C(9A)	C(10A)	C(11A)	C(16A)	178.7(7)	C(9B)	C(10B)	C(11B)	C(16B)	180.0(7)
C(10A)	C(5A)	C(6A)	C(7A)	-0.8(10)	C(10B)	C(5B)	C(6B)	C(7B)	-0.4(9)
C(10A)	C(11A)	C(12A)	C(13A)	-178.2(6)	C(10B)	C(11B)	C(12B)	C(13B)	-177.9(6)
C(10A)	C(11A)	C(16A)	C(4A)	0.1(7)	C(10B)	C(11B)	C(16B)	C(4B)	0.5(7)
C(10A)	C(11A)	C(16A)	C(15A)	180.0(6)	C(10B)	C(11B)	C(16B)	C(15B)	180.0(6)
C(11A)	C(12A)	C(13A)	C(14A)	-3.0(9)	C(11B)	C(12B)	C(13B)	C(14B)	-0.6(10)
C(12A)	C(11A)	C(16A)	C(4A)	179.6(6)	C(12B)	C(11B)	C(16B)	C(4B)	-178.3(6)
C(12A)	C(11A)	C(16A)	C(15A)	-0.5(9)	C(12B)	C(11B)	C(16B)	C(15B)	1.2(9)
C(12A)	C(13A)	C(14A)	C(15A)	1.7(10)	C(12B)	C(13B)	C(14B)	C(15B)	-1.1(10)
C(13A)	C(14A)	C(15A)	C(16A)	0.3(9)	C(13B)	C(14B)	C(15B)	C(16B)	2.8(10)
C(14A)	C(15A)	C(16A)	C(4A)	179.0(6)	C(14B)	C(15B)	C(16B)	C(4B)	176.5(6)
C(14A)	C(15A)	C(16A)	C(11A)	-0.9(9)	C(14B)	C(15B)	C(16B)	C(11B)	-2.9(9)
C(16A)	C(4A)	C(5A)	C(6A)	176.8(6)	C(16B)	C(4B)	C(5B)	C(6B)	176.8(6)
C(16A)	C(4A)	C(5A)	C(10A)	-4.0(7)	C(16B)	C(4B)	C(5B)	C(10B)	-2.8(7)
C(16A)	C(4A)	N(1A)	C(1A)	-124.4(7)	C(16B)	C(4B)	N(1B)	C(1B)	-119.9(7)
C(16A)	C(4A)	N(1A)	C(2A)	54.5(8)	C(16B)	C(4B)	N(1B)	C(2B)	57.7(8)
C(16A)	C(11A)	C(12A)	C(13A)	2.5(9)	C(16B)	C(11B)	C(12B)	C(13B)	0.6(9)
C(17A)	C(18A)	C(19A)	C(20A)	-0.2(10)	C(17B)	C(18B)	C(19B)	C(20B)	-2.1(10)
C(18A)	C(17A)	C(22A)	C(21A)	-6.1(9)	C(18B)	C(17B)	C(22B)	C(21B)	-1.9(10)
C(18A)	C(17A)	C(22A)	C(25A)	172.7(6)	C(18B)	C(17B)	C(22B)	C(25B)	-179.9(7)
C(18A)	C(17A)	N(2A)	C(1A)	93.6(8)	C(18B)	C(17B)	N(2B)	C(1B)	88.7(9)
C(18A)	C(17A)	N(2A)	C(3A)	-89.6(8)	C(18B)	C(17B)	N(2B)	C(3B)	-85.8(8)
C(18A)	C(19A)	C(20A)	C(21A)	-3.9(10)	C(18B)	C(19B)	C(20B)	C(21B)	0.0(10)
C(18A)	C(19A)	C(20A)	C(24A)	177.5(7)	C(18B)	C(19B)	C(20B)	C(24B)	-179.5(7)
C(19A)	C(20A)	C(21A)	C(22A)	3.0(10)	C(19B)	C(20B)	C(21B)	C(22B)	1.2(10)

C(20A) C(21A) C(22A) C(17A)	1.8(10)	C(20B) C(21B) C(22B) C(17B)	-0.3(10)
C(20A) C(21A) C(22A) C(25A)	-176.9(6)	C(20B) C(21B) C(22B) C(25B)	177.8(7)
C(22A) C(17A) C(18A) C(19A)	5.2(9)	C(22B) C(17B) C(18B) C(19B)	3.0(10)
C(22A) C(17A) C(18A) C(23A)	-173.2(6)	C(22B) C(17B) C(18B) C(23B)	-175.2(6)
C(22A) C(17A) N(2A) C(1A)	-88.1(8)	C(22B) C(17B) N(2B) C(1B)	-95.0(9)
C(22A) C(17A) N(2A) C(3A)	88.7(7)	C(22B) C(17B) N(2B) C(3B)	90.5(8)
C(23A) C(18A) C(19A) C(20A)	178.2(6)	C(23B) C(18B) C(19B) C(20B)	176.1(6)
C(24A) C(20A) C(21A) C(22A)	-178.4(6)	C(24B) C(20B) C(21B) C(22B)	-179.3(7)
C(26A) C(27A) C(28A) C(29A)	2.4(10)	C(26B) C(27B) C(28B) C(29B)	-0.2(10)
C(26A) C(27A) C(32A) Ru(1A)	4.5(8)	C(26B) C(27B) C(32B) Ru(1B)	5.2(8)
C(27A) C(26A) C(31A) C(30A)	-0.4(10)	C(27B) C(26B) C(31B) C(30B)	1.8(10)
C(27A) C(26A) O(1A) C(33A)	167.9(5)	C(27B) C(26B) O(1B) C(33B)	166.8(5)
C(27A) C(26A) O(1A) Ru(1A)	-0.7(6)	C(27B) C(26B) O(1B) Ru(1B)	-2.5(6)
C(27A) C(28A) C(29A) C(30A)	-0.6(10)	C(27B) C(28B) C(29B) C(30B)	0.6(10)
C(27A) C(32A) Ru(1A) C(1A)	179.8(5)	C(27B) C(32B) Ru(1B) C(1B)	176.2(5)
C(27A) C(32A) Ru(1A) Cl(1A)	-88.6(5)	C(27B) C(32B) Ru(1B) Cl(1B)	-90.7(5)
C(27A) C(32A) Ru(1A) Cl(2A)	82.1(5)	C(27B) C(32B) Ru(1B) Cl(2B)	79.6(5)
C(27A) C(32A) Ru(1A) O(1A)	-3.5(5)	C(27B) C(32B) Ru(1B) O(1B)	-4.8(5)
C(28A) C(27A) C(32A) Ru(1A)	-175.0(5)	C(28B) C(27B) C(32B) Ru(1B)	-174.3(5)
C(28A) C(29A) C(30A) C(31A)	-1.9(10)	C(28B) C(29B) C(30B) C(31B)	0.3(11)
C(29A) C(30A) C(31A) C(26A)	2.3(10)	C(29B) C(30B) C(31B) C(26B)	-1.4(11)
C(31A) C(26A) C(27A) C(28A)	-2.0(9)	C(31B) C(26B) C(27B) C(28B)	-1.0(10)
C(31A) C(26A) C(27A) C(32A)	178.4(6)	C(31B) C(26B) C(27B) C(32B)	179.4(6)
C(31A) C(26A) O(1A) C(33A)	-12.7(9)	C(31B) C(26B) O(1B) C(33B)	-13.7(9)
C(31A) C(26A) O(1A) Ru(1A)	178.8(5)	C(31B) C(26B) O(1B) Ru(1B)	177.0(5)
C(32A) C(27A) C(28A) C(29A)	-178.0(6)	C(32B) C(27B) C(28B) C(29B)	179.4(6)
C(34A) C(33A) O(1A) C(26A)	-71.6(7)	C(34B) C(33B) O(1B) C(26B)	-71.4(7)
C(34A) C(33A) O(1A) Ru(1A)	94.7(6)	C(34B) C(33B) O(1B) Ru(1B)	95.5(6)
C(35A) C(33A) O(1A) C(26A)	164.4(5)	C(35B) C(33B) O(1B) C(26B)	165.4(5)
C(35A) C(33A) O(1A) Ru(1A)	-29.3(7)	C(35B) C(33B) O(1B) Ru(1B)	-27.7(7)
N(1A) C(1A) N(2A) C(3A)	-2.7(7)	N(1B) C(1B) N(2B) C(3B)	-2.2(7)
N(1A) C(1A) N(2A) C(17A)	174.3(6)	N(1B) C(1B) N(2B) C(17B)	-176.8(6)
N(1A) C(2A) C(3A) N(2A)	-6.9(7)	N(1B) C(2B) C(3B) N(2B)	-3.9(8)
N(1A) C(4A) C(5A) C(6A)	-62.3(9)	N(1B) C(4B) C(5B) C(6B)	-62.7(9)
N(1A) C(4A) C(5A) C(10A)	116.9(6)	N(1B) C(4B) C(5B) C(10B)	117.6(6)
N(1A) C(4A) C(16A) C(11A)	-119.2(6)	N(1B) C(4B) C(16B) C(11B)	-119.8(6)
N(1A) C(4A) C(16A) C(15A)	60.9(9)	N(1B) C(4B) C(16B) C(15B)	60.8(9)
N(2A) C(1A) N(1A) C(2A)	-2.4(8)	N(2B) C(1B) N(1B) C(2B)	-0.7(8)
N(2A) C(1A) N(1A) C(4A)	176.5(6)	N(2B) C(1B) N(1B) C(4B)	177.1(6)

N(2A)	C(17A)	C(18A)	C(19A)	-176.5(6)	N(2B)	C(17B)	C(18B)	C(19B)	179.2(6)
N(2A)	C(17A)	C(18A)	C(23A)	5.1(9)	N(2B)	C(17B)	C(18B)	C(23B)	1.0(10)
N(2A)	C(17A)	C(22A)	C(21A)	175.7(6)	N(2B)	C(17B)	C(22B)	C(21B)	-178.1(6)
N(2A)	C(17A)	C(22A)	C(25A)	-5.6(9)	N(2B)	C(17B)	C(22B)	C(25B)	3.8(10)
O(1A)	C(26A)	C(27A)	C(28A)	177.5(6)	O(1B)	C(26B)	C(27B)	C(28B)	178.6(6)
O(1A)	C(26A)	C(27A)	C(32A)	-2.1(8)	O(1B)	C(26B)	C(27B)	C(32B)	-1.0(9)
O(1A)	C(26A)	C(31A)	C(30A)	-179.8(6)	O(1B)	C(26B)	C(31B)	C(30B)	-177.7(6)
Ru(1A)	C(1A)	N(1A)	C(2A)	-175.0(5)	Ru(1B)	C(1B)	N(1B)	C(2B)	-177.2(5)
Ru(1A)	C(1A)	N(1A)	C(4A)	4.0(9)	Ru(1B)	C(1B)	N(1B)	C(4B)	0.5(8)
Ru(1A)	C(1A)	N(2A)	C(3A)	168.7(5)	Ru(1B)	C(1B)	N(2B)	C(3B)	173.7(5)
Ru(1A)	C(1A)	N(2A)	C(17A)	-14.4(10)	Ru(1B)	C(1B)	N(2B)	C(17B)	-0.8(11)

Table S16. Bond lengths for **Ru12**.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C(1)	N(1)	1.349(3)	C(18)	C(23)	1.510(3)
C(1)	N(2)	1.352(3)	C(19)	C(20)	1.376(4)
C(1)	Ru(1)	1.975(2)	C(20)	C(21)	1.383(3)
C(2)	C(3)	1.516(3)	C(21)	C(22)	1.401(3)
C(2)	N(1)	1.463(3)	C(22)	C(26)	1.525(3)
C(3)	N(2)	1.473(3)	C(23)	C(24)	1.530(4)
C(4)	C(5)	1.528(3)	C(23)	C(25)	1.524(4)
C(4)	C(16)	1.525(3)	C(26)	C(27)	1.538(4)
C(4)	N(1)	1.457(3)	C(26)	C(28)	1.525(4)
C(5)	C(6)	1.378(3)	C(29)	C(30)	1.398(3)
C(5)	C(10)	1.402(3)	C(29)	C(34)	1.389(3)
C(6)	C(7)	1.395(4)	C(29)	O(1)	1.380(3)
C(7)	C(8)	1.392(4)	C(30)	C(31)	1.398(3)
C(8)	C(9)	1.382(4)	C(30)	C(35)	1.447(3)
C(9)	C(10)	1.397(3)	C(31)	C(32)	1.390(3)
C(10)	C(11)	1.467(3)	C(32)	C(33)	1.383(4)
C(11)	C(12)	1.396(3)	C(33)	C(34)	1.389(4)
C(11)	C(16)	1.402(3)	C(35)	Ru(1)	1.828(2)
C(12)	C(13)	1.379(4)	C(36)	C(37)	1.509(4)
C(13)	C(14)	1.395(4)	C(36)	C(38)	1.514(4)
C(14)	C(15)	1.398(3)	C(36)	O(1)	1.469(3)
C(15)	C(16)	1.383(4)	Cl(1)	Ru(1)	2.3167(6)
C(17)	C(18)	1.408(3)	Cl(2)	Ru(1)	2.3291(6)
C(17)	C(22)	1.398(3)	O(1)	Ru(1)	2.2943(16)
C(17)	N(2)	1.431(3)	C(39)	Cl(3)	1.770(4)
C(18)	C(19)	1.400(3)	C(39)	Cl(4)	1.733(4)

Table S17. Values of valence angles for **Ru12**.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
N(1)	C(1)	N(2)	106.85(18)	C(18)	C(23)	C(24)	111.0(2)
N(1)	C(1)	Ru(1)	121.40(15)	C(18)	C(23)	C(25)	111.3(2)
N(2)	C(1)	Ru(1)	131.25(15)	C(25)	C(23)	C(24)	110.5(2)
N(1)	C(2)	C(3)	102.72(17)	C(22)	C(26)	C(27)	110.8(2)
N(2)	C(3)	C(2)	102.47(18)	C(22)	C(26)	C(28)	111.4(2)
C(16)	C(4)	C(5)	102.03(17)	C(28)	C(26)	C(27)	110.5(3)
N(1)	C(4)	C(5)	111.64(18)	C(34)	C(29)	C(30)	120.8(2)
N(1)	C(4)	C(16)	114.54(18)	O(1)	C(29)	C(30)	113.19(19)

C(6)	C(5)	C(4)	129.0(2)	O(1)	C(29)	C(34)	125.9(2)
C(6)	C(5)	C(10)	121.0(2)	C(29)	C(30)	C(35)	118.51(19)
C(10)	C(5)	C(4)	110.0(2)	C(31)	C(30)	C(29)	119.3(2)
C(5)	C(6)	C(7)	118.6(2)	C(31)	C(30)	C(35)	122.2(2)
C(8)	C(7)	C(6)	120.5(3)	C(32)	C(31)	C(30)	120.1(2)
C(9)	C(8)	C(7)	121.2(2)	C(33)	C(32)	C(31)	119.5(2)
C(8)	C(9)	C(10)	118.3(2)	C(32)	C(33)	C(34)	121.6(2)
C(5)	C(10)	C(11)	108.8(2)	C(33)	C(34)	C(29)	118.6(2)
C(9)	C(10)	C(5)	120.3(2)	C(30)	C(35)	Ru(1)	119.89(16)
C(9)	C(10)	C(11)	130.8(2)	C(37)	C(36)	C(38)	112.3(3)
C(12)	C(11)	C(10)	130.6(2)	O(1)	C(36)	C(37)	110.8(2)
C(12)	C(11)	C(16)	120.4(2)	O(1)	C(36)	C(38)	105.5(2)
C(16)	C(11)	C(10)	108.95(19)	C(1)	N(1)	C(2)	113.68(17)
C(13)	C(12)	C(11)	118.6(2)	C(1)	N(1)	C(4)	127.30(18)
C(12)	C(13)	C(14)	121.0(2)	C(4)	N(1)	C(2)	118.94(17)
C(13)	C(14)	C(15)	120.6(3)	C(1)	N(2)	C(3)	113.27(17)
C(16)	C(15)	C(14)	118.5(2)	C(1)	N(2)	C(17)	127.58(18)
C(11)	C(16)	C(4)	110.1(2)	C(17)	N(2)	C(3)	117.96(17)
C(15)	C(16)	C(4)	129.1(2)	C(29)	O(1)	C(36)	119.49(18)
C(15)	C(16)	C(11)	120.8(2)	C(29)	O(1)	Ru(1)	109.65(13)
C(18)	C(17)	N(2)	118.3(2)	C(36)	O(1)	Ru(1)	127.94(15)
C(22)	C(17)	C(18)	122.55(19)	C(1)	Ru(1)	Cl(1)	88.46(6)
C(22)	C(17)	N(2)	119.17(19)	C(1)	Ru(1)	Cl(2)	94.98(6)
C(17)	C(18)	C(23)	122.66(19)	C(1)	Ru(1)	O(1)	176.42(7)
C(19)	C(18)	C(17)	117.3(2)	C(35)	Ru(1)	C(1)	100.82(9)
C(19)	C(18)	C(23)	120.0(2)	C(35)	Ru(1)	Cl(1)	102.25(7)
C(20)	C(19)	C(18)	121.2(2)	C(35)	Ru(1)	Cl(2)	105.01(7)
C(19)	C(20)	C(21)	120.4(2)	C(35)	Ru(1)	O(1)	78.47(8)
C(20)	C(21)	C(22)	121.1(2)	Cl(1)	Ru(1)	Cl(2)	151.33(2)
C(17)	C(22)	C(21)	117.5(2)	O(1)	Ru(1)	Cl(1)	88.27(5)
C(17)	C(22)	C(26)	123.42(19)	O(1)	Ru(1)	Cl(2)	88.59(4)
C(21)	C(22)	C(26)	119.0(2)	Cl(4)	C(39)	Cl(3)	112.9(2)

Table S18. Values of torsion angles for **Ru12**.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
C(2)	C(3)	N(2)	C(1)	-8.5(3)	C(20)	C(21)	C(22)	C(17)	-1.0(4)
C(2)	C(3)	N(2)	C(17)	-176.9(2)	C(20)	C(21)	C(22)	C(26)	175.4(2)
C(3)	C(2)	N(1)	C(1)	-8.7(3)	C(21)	C(22)	C(26)	C(27)	-54.4(3)
C(3)	C(2)	N(1)	C(4)	168.4(2)	C(21)	C(22)	C(26)	C(28)	69.0(3)
C(4)	C(5)	C(6)	C(7)	179.4(2)	C(22)	C(17)	C(18)	C(19)	0.4(3)
C(4)	C(5)	C(10)	C(9)	179.4(2)	C(22)	C(17)	C(18)	C(23)	177.3(2)
C(4)	C(5)	C(10)	C(11)	-1.7(2)	C(22)	C(17)	N(2)	C(1)	-79.6(3)
C(5)	C(4)	C(16)	C(11)	-3.1(2)	C(22)	C(17)	N(2)	C(3)	87.0(3)
C(5)	C(4)	C(16)	C(15)	179.2(2)	C(23)	C(18)	C(19)	C(20)	-177.6(2)
C(5)	C(4)	N(1)	C(1)	118.2(2)	C(29)	C(30)	C(31)	C(32)	-1.3(3)
C(5)	C(4)	N(1)	C(2)	-58.4(3)	C(29)	C(30)	C(35)	Ru(1)	-5.1(3)
C(5)	C(6)	C(7)	C(8)	1.2(4)	C(30)	C(29)	C(34)	C(33)	-2.0(4)
C(5)	C(10)	C(11)	C(12)	-179.7(2)	C(30)	C(29)	O(1)	C(36)	165.2(2)
C(5)	C(10)	C(11)	C(16)	-0.4(3)	C(30)	C(29)	O(1)	Ru(1)	3.0(2)
C(6)	C(5)	C(10)	C(9)	-1.1(3)	C(30)	C(31)	C(32)	C(33)	-0.8(4)
C(6)	C(5)	C(10)	C(11)	177.8(2)	C(30)	C(35)	Ru(1)	C(1)	-171.53(17)
C(6)	C(7)	C(8)	C(9)	-1.2(4)	C(30)	C(35)	Ru(1)	Cl(1)	-80.75(17)
C(7)	C(8)	C(9)	C(10)	0.0(4)	C(30)	C(35)	Ru(1)	Cl(2)	90.27(17)
C(8)	C(9)	C(10)	C(5)	1.1(3)	C(30)	C(35)	Ru(1)	O(1)	4.90(16)

C(8)	C(9)	C(10)	C(11)	-177.5(2)	C(31)	C(30)	C(35)	Ru(1)	174.82(17)
C(9)	C(10)	C(11)	C(12)	-0.9(4)	C(31)	C(32)	C(33)	C(34)	1.5(4)
C(9)	C(10)	C(11)	C(16)	178.4(2)	C(32)	C(33)	C(34)	C(29)	-0.1(4)
C(10)	C(5)	C(6)	C(7)	-0.1(3)	C(34)	C(29)	C(30)	C(31)	2.7(3)
C(10)	C(11)	C(12)	C(13)	179.5(2)	C(34)	C(29)	C(30)	C(35)	-177.4(2)
C(10)	C(11)	C(16)	C(4)	2.3(3)	C(34)	C(29)	O(1)	C(36)	-17.0(3)
C(10)	C(11)	C(16)	C(15)	-179.8(2)	C(34)	C(29)	O(1)	Ru(1)	-179.2(2)
C(11)	C(12)	C(13)	C(14)	0.0(4)	C(35)	C(30)	C(31)	C(32)	178.8(2)
C(12)	C(11)	C(16)	C(4)	-178.3(2)	C(37)	C(36)	O(1)	C(29)	-64.1(3)
C(12)	C(11)	C(16)	C(15)	-0.4(3)	C(37)	C(36)	O(1)	Ru(1)	94.5(2)
C(12)	C(13)	C(14)	C(15)	-0.1(4)	C(38)	C(36)	O(1)	C(29)	174.1(2)
C(13)	C(14)	C(15)	C(16)	-0.1(4)	C(38)	C(36)	O(1)	Ru(1)	-27.4(3)
C(14)	C(15)	C(16)	C(4)	177.8(2)	N(1)	C(1)	N(2)	C(3)	3.4(3)
C(14)	C(15)	C(16)	C(11)	0.4(4)	N(1)	C(1)	N(2)	C(17)	170.5(2)
C(16)	C(4)	C(5)	C(6)	-176.6(2)	N(1)	C(2)	C(3)	N(2)	9.5(3)
C(16)	C(4)	C(5)	C(10)	2.9(2)	N(1)	C(4)	C(5)	C(6)	-53.8(3)
C(16)	C(4)	N(1)	C(1)	-126.5(2)	N(1)	C(4)	C(5)	C(10)	125.7(2)
C(16)	C(4)	N(1)	C(2)	56.9(3)	N(1)	C(4)	C(16)	C(11)	-123.9(2)
C(16)	C(11)	C(12)	C(13)	0.3(3)	N(1)	C(4)	C(16)	C(15)	58.4(3)
C(17)	C(18)	C(19)	C(20)	-0.6(3)	N(2)	C(1)	N(1)	C(2)	3.7(3)
C(17)	C(18)	C(23)	C(24)	-121.6(2)	N(2)	C(1)	N(1)	C(4)	-173.1(2)
C(17)	C(18)	C(23)	C(25)	114.9(2)	N(2)	C(17)	C(18)	C(19)	-179.31(19)
C(17)	C(22)	C(26)	C(27)	121.7(3)	N(2)	C(17)	C(18)	C(23)	-2.4(3)
C(17)	C(22)	C(26)	C(28)	-114.9(3)	N(2)	C(17)	C(22)	C(21)	-179.9(2)
C(18)	C(17)	C(22)	C(21)	0.4(3)	N(2)	C(17)	C(22)	C(26)	3.9(3)
C(18)	C(17)	C(22)	C(26)	-175.8(2)	O(1)	C(29)	C(30)	C(31)	-179.3(2)
C(18)	C(17)	N(2)	C(1)	100.2(3)	O(1)	C(29)	C(30)	C(35)	0.5(3)
C(18)	C(17)	N(2)	C(3)	-93.2(3)	O(1)	C(29)	C(34)	C(33)	-179.7(2)
C(18)	C(19)	C(20)	C(21)	0.1(4)	Ru(1)	C(1)	N(1)	C(2)	-169.02(16)
C(19)	C(18)	C(23)	C(24)	55.2(3)	Ru(1)	C(1)	N(1)	C(4)	14.2(3)
C(19)	C(18)	C(23)	C(25)	-68.3(3)	Ru(1)	C(1)	N(2)	C(3)	175.07(18)
C(19)	C(20)	C(21)	C(22)	0.8(4)	Ru(1)	C(1)	N(2)	C(17)	-17.8(3)

NMR Spectra

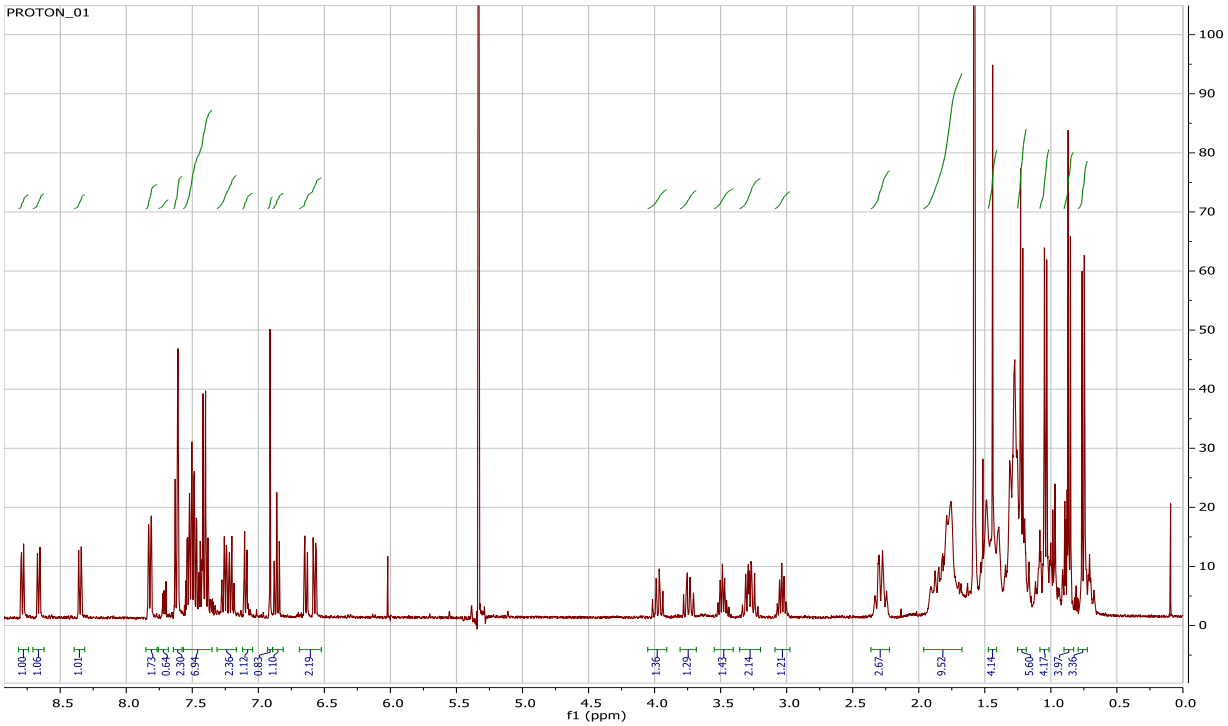


Figure S2. ^{1}H NMR of **Ru10**.

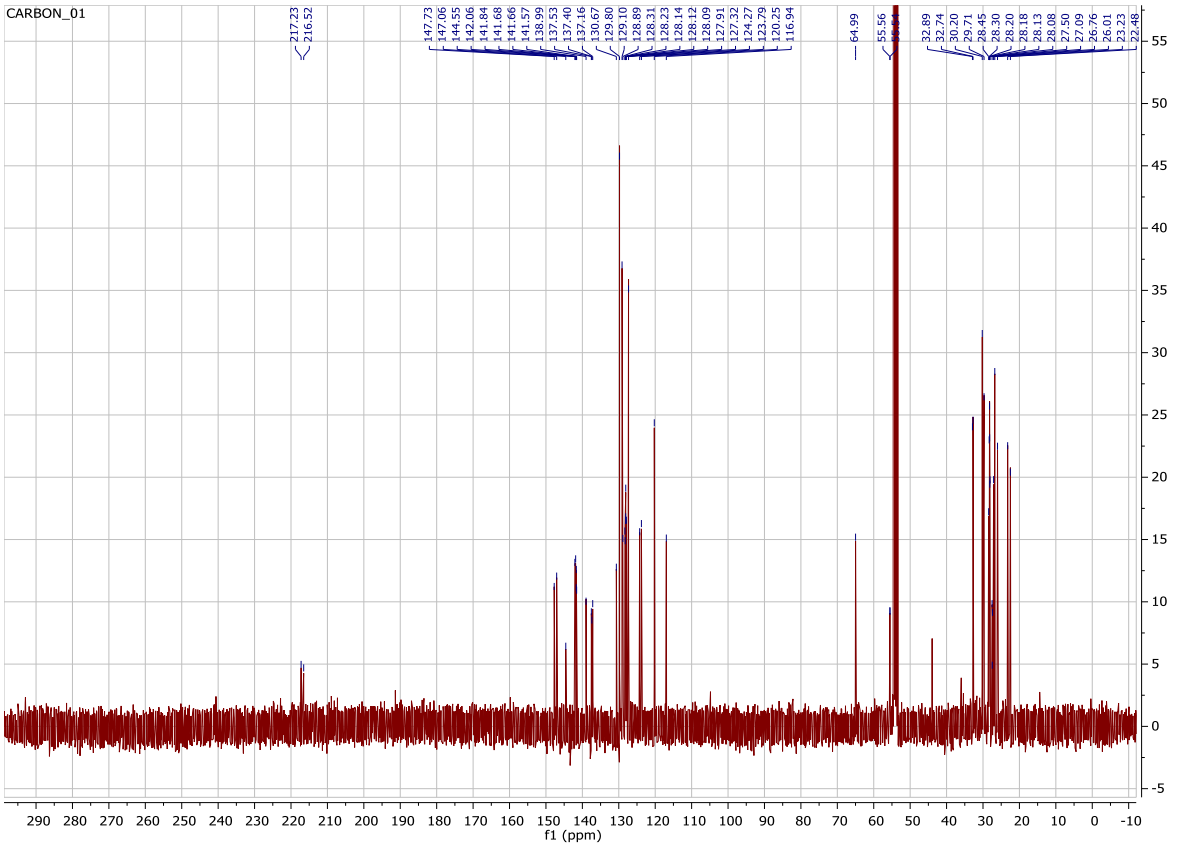


Figure S3. ^{13}C NMR of **Ru10**.

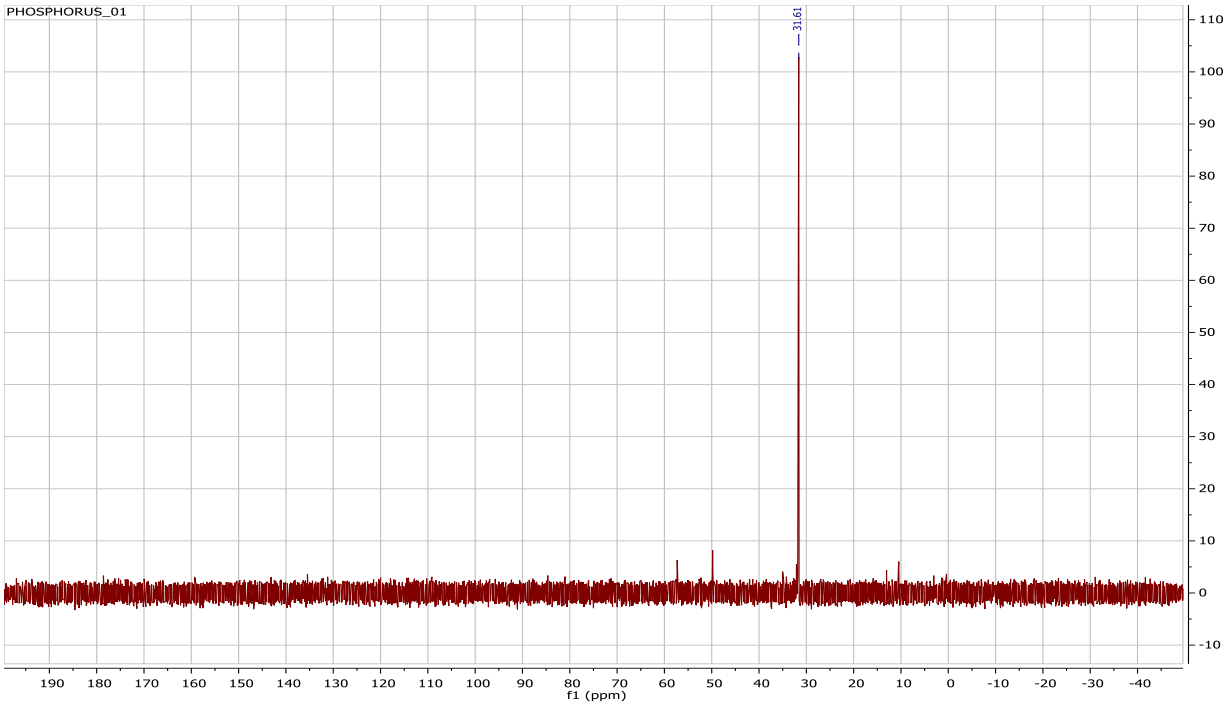


Figure S4. ^{31}P NMR of **Ru10**.

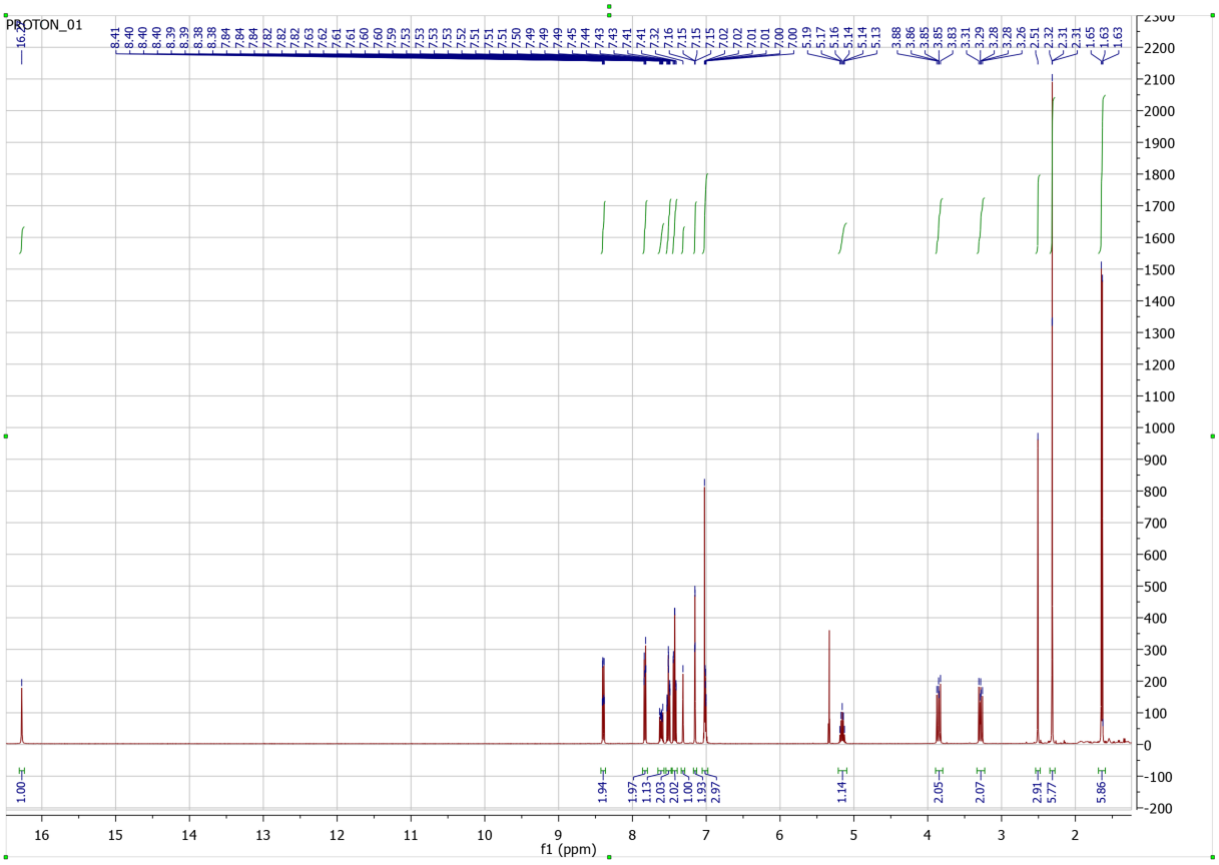


Figure S5. ^{1}H NMR of **Ru11**.

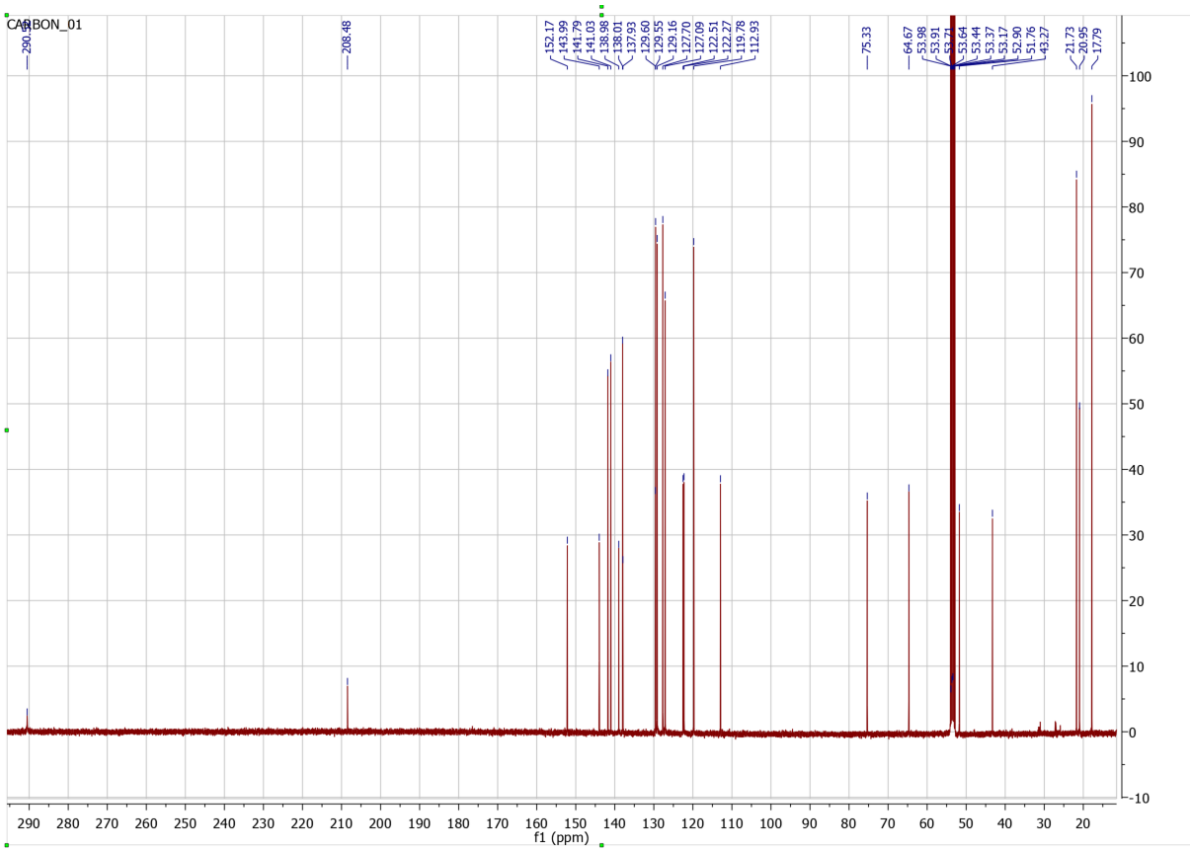


Figure S6. ^{13}C NMR of **Ru11**.

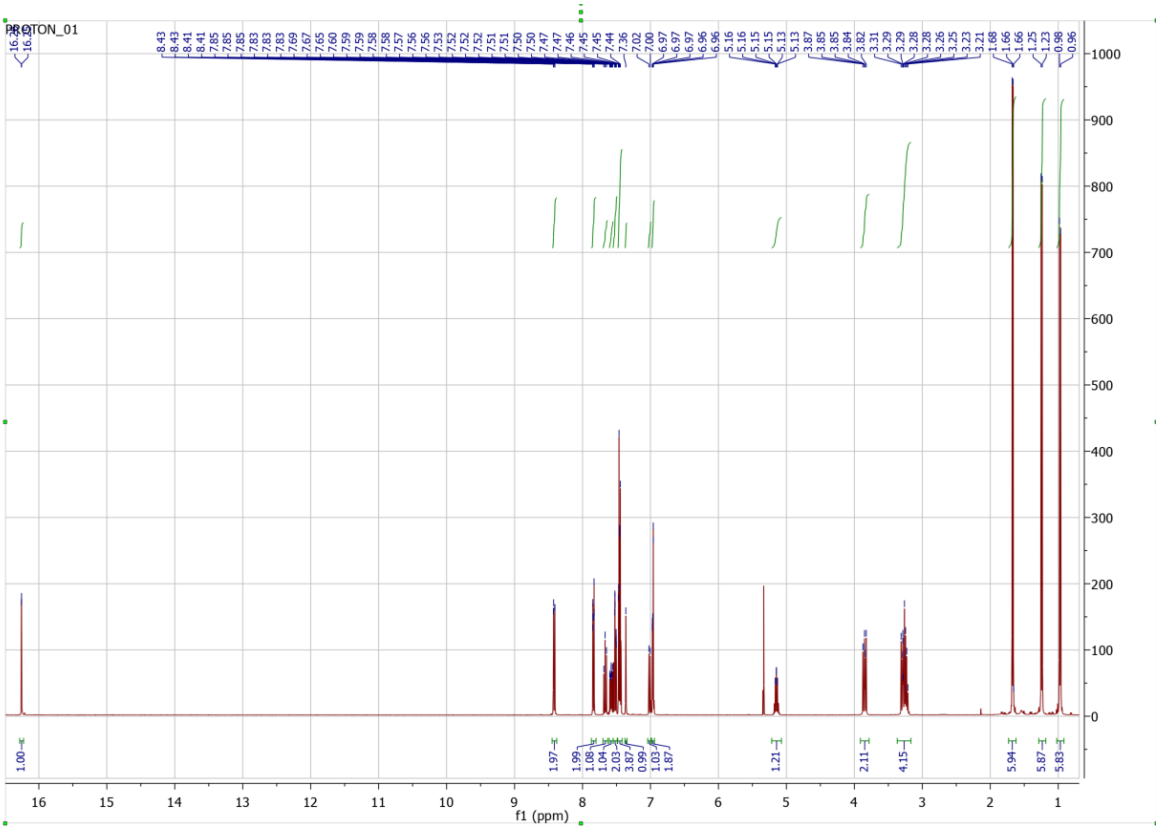


Figure S7. ^{1}H NMR of **Ru12**.

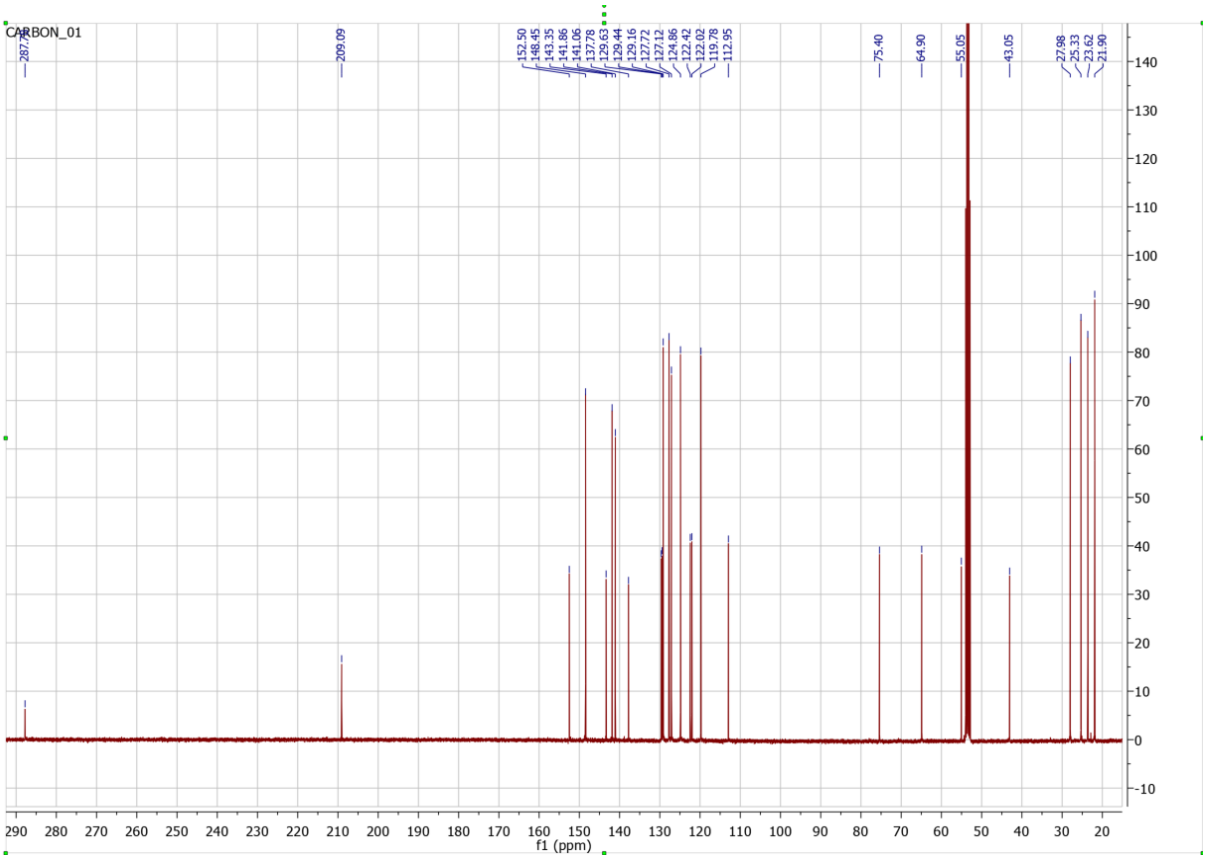


Figure S8. ^{13}C NMR of **Ru12**.

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