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Supporting Information

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Catalytic Synthesis of β^3-Amino Acid Derivatives from α-Amino Acids

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General Considerations

All manipulations of air- and/or water-sensitive compounds were carried out under dry nitrogen using an MBraun Unilab drybox or standard Schlenk line techniques. NMR spectra were recorded on a Varian Mercury (^{1}H, 300 MHz; ^{13}C, 75 MHz), Varian Inova (^{1}H, 400 MHz), or Bruker ARX (^{29}Si, 79 MHz) spectrometer and referenced versus residual non-deuterated or monoprotonated solvent shifts. ^{1}H NMR multiplicities are denoted as follows: s = singlet, d = doublet, t = triplet, br s = broad singlet, pseudo-d = pseudo-doublet, pseudo-t = pseudo-triplet, m = multiplet, dd = doublet of doublets, ddd = doublet of doublet of doublets, dt = doublet of triplets, ddt = doublet of doublet of triplets, tq = triplet of quartets. IR data were collected by a Mattson RS-10500 Research Series FTIR. Chiral HPLC (Waters 515 HPLC pump, Waters 2410 Refractive Index Detector) separations were performed on a semi-prep HPLC column ((S,S) Whelk-O 1, 10 mm, 100 A Kromasil silica), using 97:3 hexanes:isopropanol, and a flow rate of 4.5 mL/min, unless otherwise noted. X-ray crystallographic data were collected using a Bruker X8 APEX II (Mo K_α, λ = 0.71073 Å) at 173(2) K, and frames were integrated with the Bruker SAINT+ program.

Mass spectra were acquired using a JEOL GCMate II mass spectrometer operating at 500 resolving power (20% FWHM) for low resolution measurements and 3000 resolving power for high resolution measurements in positive ion mode and an electron ionization (EI) potential of 70 eV. Samples were introduced via a GC inlet using an Agilent HP 6890N GC equipped with a 30 m (0.25 μm i.d.) HP-5ms capillary GC column. The carrier gas is helium with a flow rate of 1 mL/min. Samples were introduced into the GC using a split/splitless injector at 230 ˚C with a split ratio of 10:1 (HRMS) or 50:1 (LRMS).

Carbonylations monitored by in situ IR spectroscopy were performed in a 100-mL stainless steel high pressure Parr Reactor modified for use with Mettler-Toledo ReactIR 4000 Reaction Analysis System and fitted with a Sentinel DiComp High Pressure probe. Data were acquired and analyzed using ReactIR software version 2.2.

Materials

All materials were used as received unless otherwise noted. Hexanes and toluene were each degassed by purging with nitrogen and then dried and further degassed over columns of alumina and reduced copper. Tetrahydrofuran (THF), diethyl ether, and dichloromethane were each degassed by purging with nitrogen and then dried over

columns of alumina. 1,4-Dioxane and tetrahydropyran (THP) were each vacuum transferred from Na/benzophenone after stirring at room temperature (RT) for two days. Acetonitrile was dried over CaH_2 and degassed by repetitive freeze-pump-thaw cycles. *o*-Difluorobenzene was purchased from Aldrich and dried over P_2O_5 and degassed by repetitive freeze-pump-thaw cycles. Research-grade carbon monoxide was purchased from Matheson and used as received. $CDCl_3$ and Et_2O-d_{10} were purchased from Cambridge Isotopes Laboratories and used as received. Benzene-d_6 was purchased from Cambridge Isotopes Laboratories and vacuum transferred from Na/benzophenone after stirring at RT for two days. Lithium aluminum hydride, methanesulfonyl chloride, benzonitrile, 4-*tert*-butylbenzoyl chloride, 2-amino-1-butanol, 2*R*-amino-1-butanol, DL-phenylglycine, DL-phenylalanine, *tert*-butyldimethylchlorosilane, 2-aminoethanol, L-phenylglycinol, DL-valinol, (*S*)-(+)-leucinol, (*S*)-(+)-α-methylbenzylamine were purchased from Aldrich. L-Valinol, 2-amino-1-propanol, 4-*tert*-butylbenzonitrile, and 2-amino-1,3-propanediol were purchased from TCI America, Inc. DL-Leucine was purchased from Lancaster Synthesis. Triethylamine and ethylene glycol were purchased from Fisher Chemicals. Dicobalt octacarbonyl and titanocene dicarbonyl were purchased from Strem. Triphenylsilane was purchased from Gelest, Inc. The following compounds were prepared according to literature procedure: $[Cp_2Ti(thf)_2][Co(CO)_4]$,[1] $[(salph)Al(thf)_2][Co(CO)_4]$ (salph = *N*,*N*'-*o*-phenylenebis(3,5-di-*tert*-butylsalicylideneimine)),[2] $[(salph)Cr(thf)_2][Co(CO)_4]$,[3] $[(4\text{-Cl-TPP})Al(thf)_2][Co(CO)_4]$ (4-Cl-TPP = *meso*-tetrakis(4-chlorophenyl)porphyrinato),[4] $[(TPP)Cr(thf)_2][Co(CO)_4]$ (TPP = *meso*-tetraphenylporphyrinato),[5] 2-amino-2-phenylethanol,[6] and 2-amino-3-phenylpropanol.[6] Crystalline oxazolines were dried under vacuum. Liquid oxazolines were dried over activated 4Å molecular sieves under vacuum and degassed by repetitive freeze-pump-thaw cycles. The oxazolines were filtered and stored in the drybox at ambient temperature. Optimization of catalyst loading was performed in a custom-designed and –fabricated, six-chamber, stainless steel, high pressure reactor. The reactor design allowed for incorporation of 8-mL glass vials.

Experimental Section

Synthesis of triphenylsilyl tetracarbonylcobalt(I), (1).

General procedure adapted from the method of Chalk and Harrod.[7] To an oven-dried Schlenk tube charged with a stir bar, $Co_2(CO)_8$ (746 mg, 2.18 mmol), and 10 mL hexanes, was added triphenylsilane (1.52 g, 5.84 mmol) as a solid. The reaction mixture was stirred at room temperature (RT) and the hydrogen gas evolved during this time was vented through a flow of nitrogen. After 2 h, the reaction began precipitating a tan solid. After stirring overnight (16-18 h), the dark red solution was decanted, leaving the tan powder. The solid was washed with hexanes (7 mL x 4) and dried under reduced pressure to give **1** as a white powder (1.23 g, 66% yield). ^{1}H NMR (δ, C_6D_6): 7.17 (m, 9H), 7.74 (m, 6H). ^{13}C NMR (δ, C_6D_6): 128.71, 130.31, 136.19, 139.08. ^{29}Si NMR (δ, C_6D_6): 26.57. IR (NaCl, liquid film): 2094, 2030, 1994 cm^{-1}. MS (EI) (*m*/*z*): 402 (M^+–CO), 346 (M^+–3CO), 318 (M^+–4CO), 259 (Ph_3Si^+), 181 (Ph_2Si^+). HRMS (EI) (M^+–CO) calculated 402.0123; observed 402.0113, fit –2.4 ppm.

Synthesis of 4-substituted 2-aryl-2-oxazolines.

Method A

General procedure adapted from the method of Evans et al.[8] Aminoalcohol (5.0 mL) and triethylamine (1.3 eq) were dissolved in 150 mL of dichloromethane and stirred at 0 °C. To this, a solution of 4-*tert*-butylbenzoyl chloride (0.98 eq) in 80 mL CH_2Cl_2 was added dropwise over one hour. The reaction mixture was allowed to stir at 0 °C for one hour at which point an aliquot was analyzed by ^{1}H NMR. Upon completion, the solution was charged with triethylamine (2.2 eq) and stirred at 0 °C. A solution of methanesulfonyl chloride (1.2 eq) in 80 mL CH_2Cl_2 was added dropwise over 1 h. The reaction was stirred overnight and allowed to warm to RT. After analysis by ^{1}H NMR spectroscopy, the mixture was then washed twice with water and once with brine. After drying over anhydrous Na_2SO_4, the mixture was filtered, treated with activated charcoal, and filtered through a pad of Celite 545 on a glass frit. The solution was concentrated under reduced pressure and purified as noted.

Method B

General procedure adapted from the method of Schumacher et al.[9] A 50-mL, Schlenk-adapted, round-bottom flask was charged with 2-amino-1-propanol (5.0 mL, 53 mmol), K_2CO_3 (696 mg, 5.038 mmol), ethylene glycol (13 mL). The mixture was heated to 110 °C (140 °C for 4-*tert*-butylbenzonitrile) under a blanket of nitrogen. Benzonitrile (5.0 mL, 49 mmol) was added all at once and the flask was sealed. The reaction was vented periodically for the first hour, at which point gas evolution ceased. The reaction was monitored by TLC and typically complete after 6 h. After cooling to room temperature, the reaction mixture was treated with hexanes and water. The hexanes layer was washed with water twice and the aqueous fractions combined. The aqueous layer was then washed with hexanes once and the organic layers combined. After drying over sodium sulfate and filtering, the organic layer was concentrated under reduced pressure. Excess aminoalcohol and unreacted benzonitrile were removed by careful vacuum distillation. The product, 4-ethyl-2-phenyl-2-oxazoline, was then distilled under vacuum (54-58 °C) in a 42.3% yield (3.92 g). ^{1}H NMR (δ, $CDCl_3$): 0.99 (t, ^3J = 7.3 Hz, 3H), 1.63 (m, 1H), 1.77 (m, 1H), 4.05 (pseudo-t, ^3J = 7.8 Hz, 1H), 4.24 (ddt, ^3J = 5.7 Hz, ^3J = 9.3 Hz, ^3J = 7.3 Hz, 1H), 4.47 (dd, ^3J = 9.3 Hz, ^3J = 8.1 Hz, 1H), 7.39 (m, 3H), 7.95 (m, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.08, 28.70, 68.00, 72.22, 127.92, 128.31, 128.37, 131.32, 163.56. IR (neat): 1651 cm^{-1}.

The 4-*tert*-butylphenyl substituted oxazolines were synthesized and purified as noted. Vacuum distillations were performed at 200 mTorr.

4-Methyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2a**): Method A; Vacuum distilled (92-100 °C, crystallized upon warming). 11.83 g, (84%). ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.35 (d, ^3J = 6.4 Hz, 3H), 3.94 (t, ^3J = 7.7 Hz, 1H), 4.36 (tq, ^3J = 6.4 Hz, ^2J = 9.3 Hz, 1H), 4.50 (dd, ^3J = 6.0 Hz, ^2J = 9.3 Hz, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 21.61, 31.26, 35.03, 62.00, 74.05, 125.07, 125.36, 128.10, 154.79, 163.55. IR (liquid film): 1648 cm^{-1}.

4-Ethyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2b**): Method A; Vacuum distilled (90-96 °C, crystallized upon warming). 9.69 g, (79%). ^{1}H NMR (δ, $CDCl_3$): 0.98 (t, ^3J = 7.5 Hz, 3H),

1.32 (s, 9H), 1.61 (m, 1H), 1.75 (m, 1H), 4.03 (t, ^3J = 7.8 Hz, 1H), 4.23 (m, 1H), 4.45 (dd, ^3J = 8.1 Hz, ^3J = 9.3 Hz, 1H), 7.41 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.00, 28.70, 31.25, 35.00, 67.96, 72.04, 125.15, 125.32, 128.09, 154.69, 163.49. IR (liquid film): 1650 cm^{-1}. Chiral HPLC (97:3 Hexanes:Isopropanol; 4.5 mL/min): (*S*)-**2b**, 7.995 min.; (*R*)-**2b**, 11.12 min.

(4*R*)-4-Ethyl-2-(4-*tert*-butylphenyl)-2-oxazoline ((*R*)-**2b**): Method A; Vacuum distilled (88-96 °C). 11.34 g, (87%). ^{1}H NMR (δ, $CDCl_3$): 0.98 (t, ^3J = 7.4 Hz, 3H), 1.33 (s, 9H), 1.69 (m, 2H), 4.04 (t, ^3J = 7.9 Hz, 1H), 4.23 (dtd, ^3J = 5.7 Hz, ^3J = 7.5 Hz, ^3J = 9.5 Hz, 1H), 4.45 (dd, ^3J = 7.9 Hz, ^2J = 9.3 Hz, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.02, 28.71, 31.28, 35.03, 67.97, 72.06, 125.16, 125.35, 128.11, 154.72, 163.52. IR (neat): 1650 cm^{-1}.

4-(2-Methyl)propyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2c**): Method A; Vacuum distillation at 114-118 °C gave a yellow liquid. Flash chromatography through Fluorosil D using CH_2Cl_2 and then diethyl ether followed by a second vacuum distillation (104-108 °C) gave a clear, colorless liquid, 6.52 g, (54%). ^{1}H NMR (δ, $CDCl_3$): 0.96 (d, ^3J = 6.6 Hz, 3H), 0.98 (d, ^3J = 6.6 Hz, 3H), 1.33 (s, 9H), 1.38 (m, 1H), 1.76 (m, 2H), 3.99 (t, ^3J = 8.1 Hz, 1H), 4.32 (ddt, ^3J = 6.0 Hz, ^3J = 8.0 Hz, ^2J = 9.3 Hz, 1H), 4.50 (dd, ^3J = 8.0 Hz, ^2J = 9.3 Hz, 1H), 7.42 (pseudo-d, 2H), 7.88 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 22.75, 23.11, 25.57, 31.26, 35.04, 45.68, 64.97, 73.18, 124.97, 125.39, 128.17, 154.87, 163.55. IR (neat): 1650 cm^{-1}. Chiral HPLC (97:3 Hexanes:Isopropanol; 4.5 mL/min): (*R*)-**2c**, 8.226 min.; (*S*)-**2c**, 6.240 min.

(4*S*)-4-(2-Methyl)propyl-2-(4-*tert*-butylphenyl)-2-oxazoline ((*S*)-**2c**): Method B; Vacuum distilled twice at 90-96 °C, 2.37 g (41% yield). ^{1}H NMR (δ, $CDCl_3$): 0.96 (d, ^3J = 5.1 Hz, 3H), 0.98 (d, ^3J = 5.1 Hz, 3H), 1.33 (s, 9H), 1.37 (m, 1H), 1.71 (m, 1H), 1.80 (m, 1H), 3.98 (t, ^3J = 7.8 Hz, 1H), 4.32 (ddt, ^3J = 6.0 Hz, ^2J = 9.3 Hz, ^3J = 7.8 Hz , 1H), 4.49 (dd, ^3J = 7.8 Hz, ^2J = 9.3 Hz, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 22.88, 23.24, 25.71, 31.40, 35.18, 45.86, 65.24, 73.24, 125.27, 125.48, 128.24, 154.87, 163.53. IR (neat): 1650 cm^{-1}.

4-Benzyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2d**): Method A; Sublimed, 2.58 g, (25%). ^{1}H NMR (δ, $CDCl_3$): 1.34 (s, 9H), 2.72 (dd, ^3J = 8.7 Hz, ^2J = 13.6 Hz, 1H), 3.25 (dd, ^3J = 5.1 Hz, ^2J = 13.6 Hz, 1H), 4.13 (dd, ^3J = 7.2 Hz, ^2J = 8.7 Hz, 1H), 4.33 (dd, ^2J = 8.7 Hz, ^3J = 9.0 Hz, 1H), 4.57 (ddt, ^3J = 5.1 Hz, ^3J = 7.2 Hz, ^3J = 8.7 Hz, 1H), 7.29 (m, 5H), 7.43 (pseudo-d, 2H), 7.88 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.29, 35.07, 42.00, 67.93, 71.87, 125.00, 125.42, 126.60, 128.19, 128.67, 129.39, 138.18, 154.95, 164.15. IR (liquid film): 1648 cm^{-1}.

4-Isopropyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2f**): Method B; Sublimed (60-75 °C), 5.29 g, (66%). ^{1}H NMR (δ, $CDCl_3$): 0.97 (t, ^3J = 6.7 Hz, 3H), 1.33 (s, 9H), 1.87 (m, 1H), 4.13 (m, 2H), 4.39 (m, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 18.03, 19.03, 31.27, 32.86, 35.01, 69.93, 72.55, 125.18, 125.33, 128.13, 154.66, 163.40. IR (liquid film): 1651 cm^{-1}. Chiral HPLC (97:3 Hexanes:Isopropanol; 4.5 mL/min): (*R*)-**2f**, 6.993 min.; (*S*)-**2f**, 5.506 min.

(4*S*)-4-Isopropyl-2-(4-*tert*-butylphenyl)-2-oxazoline ((*S*)-**2f**): Method B; Vacuum distilled twice at 90-96 °C, 3.33 g (50% yield). ^{1}H NMR (δ, $CDCl_3$): 0.92 (d, ^{3}J = 6.6 Hz, 3H), 1.02 (d, ^{3}J = 6.6 Hz, 3H), 1.33 (s, 9H), 1.87 (m, 1H), 4.12 (m, 2H), 4.38 (m, 1H), 7.42 (pseudo-d, 2H), 7.88 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 18.15, 19.15, 31.40, 32.97, 35.16, 70.10, 72.61, 125.23, 125.47, 128.29, 154.86, 163.60. IR (neat): 1651 cm^{-1}.

4-Phenyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2g**): Method A; Recrystallized from hexanes, 2.40 g, (24%). ^{1}H NMR (δ, $CDCl_3$): 1.35 (s, 9H), 4.27 (t, ^{3}J = 8.1 Hz, 1H), 4.79 (dd, ^{3}J = 8.4 Hz, ^{2}J = 10.2 Hz, 1H), 5.38 (dd, ^{3}J = 7.8 Hz, ^{2}J = 9.9 Hz, 1H), 7.32 (m, 5H), 7.47 (pseudo-d, 2H), 7.99 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.27, 35.11, 70.06, 74.98, 124.67, 125.50, 126.87, 127.71, 128.44, 128.84, 142.55, 155.24, 164.96. IR (liquid film): 1645 cm^{-1}. Chiral HPLC (75:25 Hexanes:Isopropanol; 4.5 mL/min): (*R*)-**2g**, 15.94 min.; (*S*)-**2g**, 5.954 min.

(4*R*)-4-Phenyl-2-(4-*tert*-butylphenyl)-2-oxazoline ((*R*)-**2g**): Method A; Recrystallized from hexanes, 5.12 g, (50%). ^{1}H NMR (δ, $CDCl_3$): 1.36 (s, 9H), 4.27 (t, ^{3}J = 8.1 Hz, 1H), 4.79 (dd, ^{3}J = 8.7 Hz, ^{2}J = 10.2 Hz, 1H), 5.38 (dd, ^{3}J = 8.1 Hz, ^{2}J = 10.2 Hz, 1H), 7.32 (m, 5H), 7.47 (pseudo-d, 2H), 7.99 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.27, 35.09, 70.14, 74.95, 124.75, 125.47, 126.86, 127.69, 128.41, 128.83, 142.62, 155.17, 164.88. IR (liquid film): 1646 cm^{-1}.

5-Methyl-2-(4-*tert*-butylphenyl)-2-oxazoline (**2h**): Method A; Vacuum distilled (84-90 °C, crystallized upon warming). 8.71 g, (63%). ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.41 (d, ^{3}J = 6.2 Hz, 3H), 3.60 (dd, ^{3}J = 7.1 Hz, ^{2}J = 14.3 Hz, 1H), 4.13 (dd, ^{3}J = 9.4 Hz, ^{2}J = 14.3 Hz, 1H), 4.83 (ddq, ^{3}J = 6.3 Hz, ^{3}J = 7.1 Hz, ^{3}J = 9.2 Hz, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 21.25, 31.26, 35.02, 61.55, 76.21, 125.24, 125.36, 128.01, 154.75, 164.00. IR (liquid film): 1646 cm^{-1}.

(5*R*)-5-Methyl-2-(4-tert-butylphenyl)-2-oxazoline ((*R*)-2h): Method B; Sublimed. 1.68 g, (44%). ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.41 (d, ^{3}J = 6.3 Hz, 3H), 3.60 (dd, ^{3}J = 7.3 Hz, ^{2}J = 14.4 Hz, 1H), 4.13 (dd, ^{3}J = 9.3 Hz, ^{2}J = 14.4 Hz, 1H), 4.83 (ddq, ^{3}J = 6.3 Hz, ^{3}J = 7.3 Hz, ^{3}J = 9.3 Hz, 1H), 7.42 (pseudo-d, 2H), 7.87 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 21.37, 31.38, 35.13, 61.75, 76.28, 125.42, 125.46, 128.10, 154.81, 164.07. IR (liquid film): 1648 cm^{-1}.

Synthesis of 4-(*tert*-butyldimethylsilyloxymethyl)methyl-2-(4-*tert*-butylphenyl)-2-oxazoline (2e).

This compound was synthesized using a modified procedure from Schumacher et al.[9] A 100-mL, Schlenk-adapted, round-bottom flask was charged with 2-amino-1,3-propanediol (2.92 g, 32.0 mmol), K_2CO_3 (551 mg, 3.99 mmol), and ethylene glycol (8 mL). The mixture was heated to 140 °C under a blanket of nitrogen. 4-*tert*-Butylbenzonitrile (5.0 mL, 30. mmol) was added in one portion and the flask was sealed. The reaction was vented periodically for the first hour, at which point gas evolution ceased. The reaction was monitored by TLC and was complete after 6 h. Ethylene glycol was removed by vacuum distillation and the crude mixture was combined with CH_2Cl_2,

giving a cloudy pink solution. The solution was treated with activated charcoal, filtered through Celite 545 and concentrated to give crude product in a quantitative yield (6.90 g). This material was used without further purification. ^{1}H NMR (δ, $CDCl_3$): 1.31 (s, 9H), 3.65 (dd, ^2J = 11.7 Hz, ^3J = 3.4 Hz, 1H), 3.95 (dd, ^2J = 11.7 Hz, ^3J = 2.9 Hz, 1H), 4.39 (m, 3H), 7.32 (pseudo-d, 2H), 7.73 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.20, 33.98, 63.75, 68.02, 69.20, 124.31, 125.26, 128.12, 154.93, 165.65.

The crude oxazoline (5.60 g, 24.0 mmol) was combined with triethylamine (5.0 mL, 36 mmol) and 60 mL CH_2Cl_2. The solution was stirred at RT and a solution of *tert*-butyldimethylchlorosilane (5.58 g, 37.0 mmol) in 40 mL CH_2Cl_2 over 15 minutes. The reaction was stirred for 2 d at RT. After completion was confirmed by ^{1}H NMR spectroscopy, the reaction mixture was washed twice with water and once with brine. After drying over sodium sulfate and filtering, the solution was concentrated under reduced pressure to yield an orange oil. The product was crystallized from acetonitrile at –20 °C and then sublimed at 75-80 °C to give 2.8 g (33 %) of oxazoline **2e**. ^{1}H NMR (δ, $CDCl_3$): 0.03 (s, 3H), 0.07 (s, 3H), 0.86 (s, 9H), 1.33 (s, 9H), 3.61 (dd, ^3J = 5.7 Hz, ^2J = 9.9 Hz, 1H), 3.91 (dd, ^3J = 8.4 Hz, ^2J = 10.2 Hz, 1H), 4.40 (m, 3H), 7.41 (pseudo-d, 2H), 7.86 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): -5.21, -5.19, 18.36, 25.94, 31.28, 35.04, 65.29, 68.26, 70.44, 125.03, 125.36, 128.16, 151.11, 154.85, 164.95. IR (liquid film): 1650 cm^{-1}.

NMR spectroscopic studies on $Ph_3SiCo(CO)_4$ and BnOH

Reaction of **1** and BnOH in C_6D_6

In a glove box, a 20-mL scintillation vial was charged with **1** (20.41 mg, 0.0474 mmol) and 0.6 mL C_6D_6. The solid was dissolved and the solution was transferred to a J. Young tube. After recording a ^{1}H NMR spectrum, 20 μL of a 0.24 mM solution of benzyl alcohol in C_6D_6 was added. The tube was shaken and a spectrum acquired immediately after addition. There was little to no change in the spectrum compared to that of pure **1**. After 24 h, another spectrum was recorded which displayed peaks that correspond to $HCo(CO)_4$ and H_2. Another 180 μL of the benzyl alcohol solution was added and a new spectrum was acquired. No further change was observed in the spectrum and the sample was allowed to stand at room temperature. Subsequent spectra were recorded at t = 7 h, t = 24 h, and t = 120 h. The integration for the $HCo(CO)_4$ peak remained small, while the H_2 peak grew significantly over this time.

Reaction of **1** and BnOH in Et_2O-d_{10}

In a glove box, a 20-mL scintillation vial was charged with **1** (19.33 mg, 0.0449 mmol) and 0.6 mL Et_2O-d_{10}. The solid was dissolved and the solution transferred to a J. Young tube. After 4 h, a spectrum was recorded and 40 μL of a 1.12 mM solution of benzyl alcohol in Et_2O-d_{10} was added. The solution turned dark red and the ^{1}H NMR spectrum was acquired immediately upon addition (t = 0 h). The spectrum was consistent with the generation of $HCo(CO)_4$. The reaction was monitored again at t = 24 h and t = 96 h, both spectra of which displayed an H_2 peak and no $HCo(CO)_4$.

Reaction of **1**, BnOH, and **2h** in Et_2O-d_{10}

In a glove box, a solution of **1** (20.68 mg, 0.0481 mmol) in 0.3 mL Et_2O-d_{10} was combined with a solution of **2h** (9.92 mg, 0.0456 mmol) in 0.3 mL Et_2O-d_{10} in a 20-mL scintillation vial. The solution was shaken to dissolve all solids, transferred to a J. Young tube, and an initial spectrum was recorded. To this tube was added 40 μL of a 1.15 mM solution of benzyl alcohol in Et_2O-d_{10}. Upon addition of the alcohol, the solution turns dark red. A ^{1}H NMR spectrum was acquired immediately after addition (t=0) and displayed peaks consistent with a protonated oxazoline species. The reaction was monitored again at t = 24 h and t = 72 h with no evident changes in either spectrum. [H-**2h**]$^+$[Co(CO)$_4$]$^-$: ^{1}H NMR (δ, Et_2O-d_{10}): 1.21 (s, 9 H), 1.43 (d, ^3J = 6.0 Hz, 3 H), 3.66 (dd, ^2J = 12.6 Hz, ^3J = 8.2 Hz, 1 H), 4.24 (dd, ^2J = 12.6 Hz, ^3J = 9.8 Hz, 1 H), 5.19 (m, 1 H), 7.45 (pseudo-d, 2 H), 7.86 (2 H, pseudo-d), 11.68 (br s, 1 H).

Carbonylation of Oxazolines

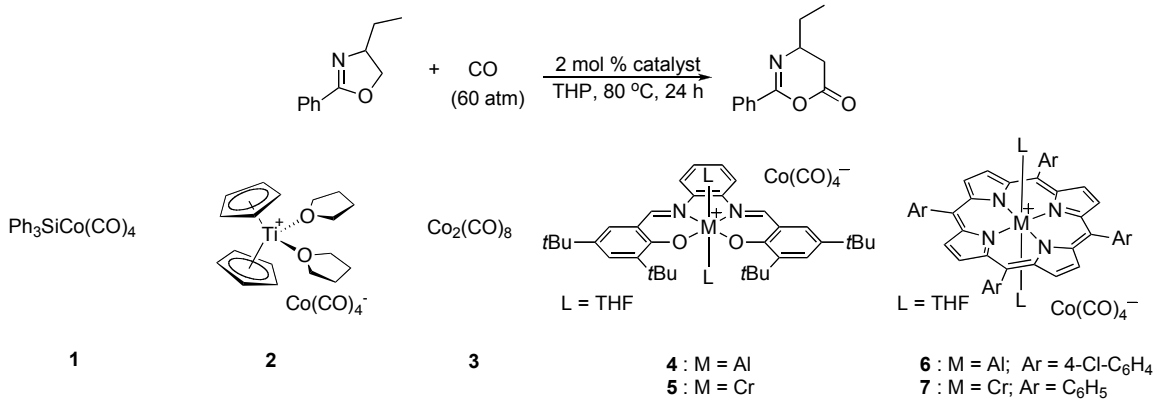
In a custom-made, six-well, high pressure, stainless steel reactor, six 8-mL vials containing stir bars were charged with catalyst followed by a solution of oxazoline (1 mmol) in 2 mL THP. The reactor was sealed and the system pressurized with CO. Each well was closed individually and the reactor heated to 80 °C for the appropriate time. After this time, the reactor was placed in dry ice for 15 minutes. Each well was vented to the headspace, the headspace vented in a well-ventilated hood, and the reactor disassembled.

The reaction mixture was then quenched with 1 mL CH_2Cl_2 and stirred for 10 minutes. The volatiles were removed under reduced pressure and the residue was dissolved in pentane (acetonitrile for **3d**, (*R*)-**3g**, and **3g**). The mixtures were then filtered and concentrated to give the product as an oil, which was then analyzed by ^{1}H NMR spectroscopy. Conversion and product distribution were determined from the integration of the requisite peaks identifying oxazoline and oxazinone. Reaction mixtures were then purified using the methods noted in the characterization section.

Screening Reactions

Catalyst screening (Table S1). These carbonylations were performed according to the above procedure.

Table S1. Carbonylations of 4-Ethyl-2-phenyl-2-oxazoline: Catalyst Screening Reactions.[a]



1 **2** **3** **4** : M = Al; **5** : M = Cr **6** : M = Al; Ar = 4-Cl-C_6H_4; **7** : M = Cr; Ar = C_6H_5

Entry	Catalyst	Conversion [b] [%]
1	**1**	75
2	**2**	12
3	**3**	26
4	**4**	24
5	**5**	27
6	**6**	13
7	**7**	7

[a] All reactions were performed using 2 mol% catalyst, 1 mmol 4-ethyl-2-phenyl-2-oxazoline, 60 atm CO, 2 mL THP, 80 °C, 24 h. [b] Conversion to oxazinone determined by ^{1}H NMR spectroscopy.

Carbonylation of **2b** using **1**/BnOH and 6.8 atm CO

This reaction was performed in a custom-made six-well reactor as described above. In this case, the well was pressurized with 6.8 atm CO and sealed. After a reaction time of 6 h, the reactor was disassembled as described above and the reaction mixture was analyzed by ^{1}H NMR spectroscopy. The ^{1}H NMR spectrum of the reaction mixture is shown in Figure S1.

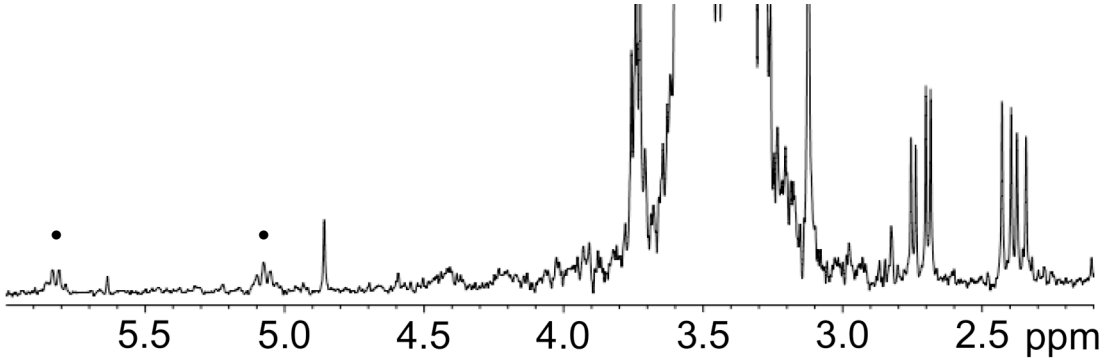


Figure S1. ^{1}H NMR spectrum (δ 2 – 6 ppm) of the carbonylation of **2b** using **1**/BnOH and 6.8 atm CO. The peaks at 2.38 and 2.71 ppm represent **3b** and those at 5.08 and 5.81 ppm (denoted by bullets) are tentatively assigned to the *cis*- and *trans*-*N*-alkenyl benzamides. Unreacted oxazoline is present around 4.2 and 4.4 ppm and DME appears between 3.0 and 4.0 ppm.

Oxazoline carbonylation monitored by *in situ* IR spectroscopy

Carbonylation of **2a** using **1**

The assembled Parr reactor was dried at 90 °C under vacuum overnight and allowed to cool. It was then sealed under vacuum and brought into the glove box. A solution of **1** (68.5 mg, 0.159 mmol) in toluene (1.8 ml) was prepared in a scintillation vial, and 1.0 ml was drawn into a glass syringe. The needle was inserted through a septum covering the injection port of the reactor. A 0.17 M solution of oxazoline **2a** (329.0 mg, 1.514 mmol) in THP (9.0 mL) was prepared in a 20-mL scintillation vial and 8.5 mL were drawn into a 10-mL glass syringe, which was capped with a septum. The reactor was removed from the glove box and connected to the React-IR. After ~5 min., a background spectrum (16 scans) was recorded. Following this, IR spectra (16 scans/spectrum at a gain of 2 and a resolution of 4 cm^{-1}) were recorded every minute. After the first spectrum was recorded, the precatalyst solution was injected into the reactor, and the solution stirred for 2 minutes. The portion of THP was injected and the mixture stirred at room temperature for 30 minutes, during which time IR spectra were recorded every minute. Due to the lack of any peaks in the IR spectra corresponding to **1**, $HCo(CO)_4$, or $[Co(CO)_4]^-$, the substrate solution was injected and the system was immediately pressurized with CO to 60 atm. The reactor was wrapped in a heating jacket

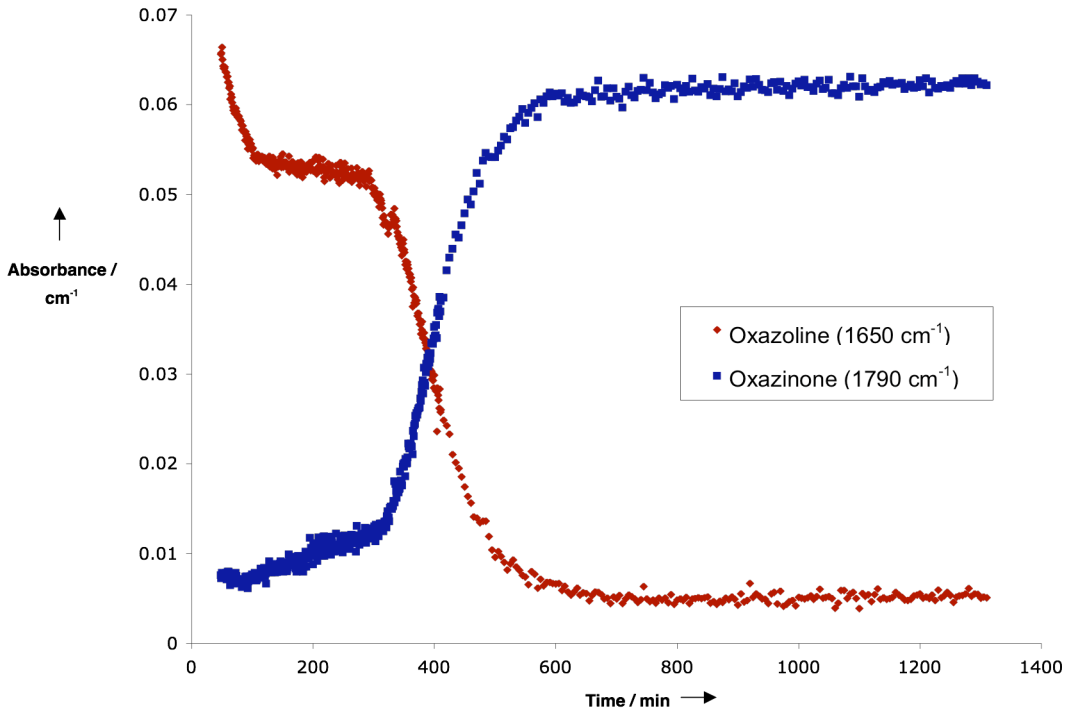


Figure S2. Carbonylation of 4-methyl-2-(*p*-tert-butylphenyl)-2-oxazoline (**2a**) using **1** monitored by in situ IR spectroscopy. Reaction conditions: 1.36 mmol oxazoline (0.17 M in THP), 0.133 mmol **1** (88 mM in toluene), 60 atm CO, 80 °C. The initial decrease in oxazoline and concomitant increase in oxazinone occurred while the reaction was heated at 60 °C. The reaction was subsequently heated to 80 °C.

and the temperature set to 60 °C. After 2 h, no significant product formation was observed and the reactor was then heated to 80 °C. The formation of the product was recorded via the emergence of two stretches: the carbonyl stretch (1790 cm^{-1}) and the amide stretch (1670 cm^{-1}). The reaction was allowed to proceed until no more oxazinone was being formed (i.e. the oxazinone absorbances were constant). The reactor was allowed to cool and was then vented carefully in a vacuum hood. Crude reaction mixture was transferred to a scintillation vial and analyzed by ^{1}H NMR spectroscopy. The plot of IR absorbance versus time is shown in Figure S2. The absorbance is approximately proportional to concentration.

Carbonylation of **2a** using **1** and methanol

The assembled Parr reactor was dried at 90 °C under vacuum overnight and allowed to cool. It was then sealed under vacuum and brought into the glove box. A solution of **1** (71.4 mg, 0.166 mmol) in toluene (1.5 ml) was prepared in a scintillation vial, and 1.0 ml was drawn into a glass syringe. The needle was inserted through a septum covering the injection port of the reactor. A solution of oxazoline **2a** (352.1 mg, 1.620 mmol) in THP (10 mL) was prepared in a 20-mL scintillation vial and 8.7 mL were drawn into a glass syringe, which was also inserted through the septum. A 50-mL round-

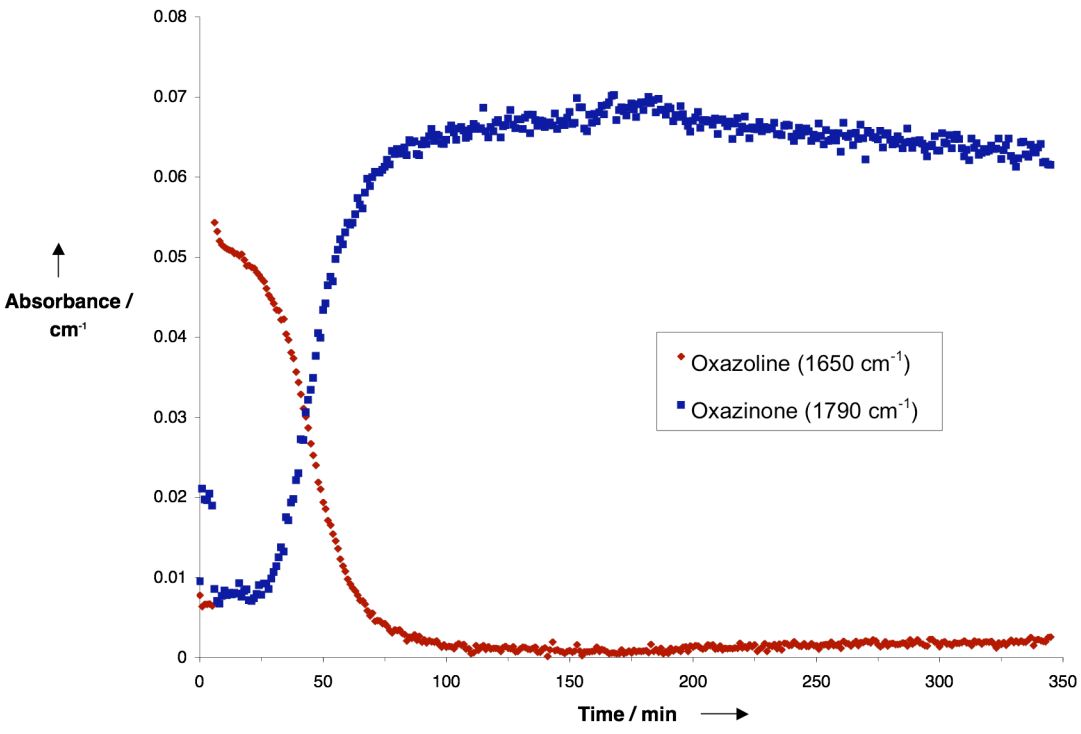


Figure S3. Carbonylation of 4-methyl-2-(*p*-tert-butylphenyl)-2-oxazoline (**2a**) using **1**/MeOH monitored by in situ IR spectroscopy. Reaction conditions: 1.41 mmol oxazoline (0.16 M in THP), 0.111 mmol **1** (0.11 M in toluene), 98.8 μmol methanol (0.25 M in toluene), 60 atm CO, 80 °C. The initial drop in absorbance for oxazoline is due to dilution from CO pressure. The drop in absorbance for oxazinone at approximately 170 min. is a response to the release of CO pressure.

bottom flask fitted with a Schlenk adapter was charged with methanol (0.10 mL, 2.4 mmol) and toluene (10. mL). The reactor was removed from the glove box and connected to the React-IR. After ~5 min., a background spectrum (16 scans) was recorded. Following this, IR spectra (16 scans/spectrum at a gain of 2 and a resolution of 4 cm^{-1}) were recorded every minute. After the first spectrum was recorded, the precatalyst solution was injected into the reactor, and the solution stirred for 2 minutes. The methanol solution (0.4 mL) was then injected and the mixture stirred for 2 minutes. Substrate was then injected and the system was immediately pressurized with CO to 60 atm. The small initial drop in IR absorbance is an artifact of dilution upon pressurizing the system. The reactor was wrapped in a heating jacket and the temperature set to 80 °C. The formation of the product was recorded via the emergence of two stretches: the carbonyl stretch (1790 cm^{-1}) and the amide stretch (1670 cm^{-1}). The reaction was allowed to proceed until no more oxazinone was being formed (i.e. the oxazinone absorbances were constant). The CO was vented and the reaction allowed to stir at 80 °C for an additional 3 h. The reactor was then allowed to cool and crude reaction mixture was transferred to a scintillation vial and analyzed by ^{1}H NMR spectroscopy. The plot of IR absorbance versus time is shown in Figure S3. The absorbance is approximately proportional to concentration.

Purification and Characterization of 2-Aryl-2-Oxazin-6-ones.

Reaction mixtures were treated as noted above and products were purified as noted below.

4-Ethyl-2-phenyl-2-oxazinone: Passed through silica gel using CH_2Cl_2 (R_f = 0.27). ^{1}H NMR (δ, $CDCl_3$): 1.09 (t, ^{3}J = 7.4 Hz, 3H), 1.71 (m, 2H), 2.43 (dd, ^{3}J = 9.9 Hz, ^{2}J = 16.2 Hz, 1H), 2.77 (dd, ^{3}J = 5.1 Hz, ^{2}J = 16.2 Hz, 1H), 3.77 (m, 1H), 7.42 (m, 3H), 8.05 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.22, 28.88, 33.30, 54.59, 127.78, 128.53, 131.81, 135.09, 152.47, 166.67. IR (liquid film): 1674, 1788 cm^{-1}. HRMS (EI) calculated 203.09463; measured 203.09510, fit 2.3 ppm.

4-Methyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3a**): Passed through silica gel using CH_2Cl_2 (R_f = 0.29). ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.39 (d, ^{3}J = 6.9 Hz, 3H), 2.41 (dd, ^{3}J = 9.1 Hz, ^{2}J = 15.9 Hz, 1H), 2.77 (dd, ^{3}J = 5.0 Hz, ^{2}J = 15.9 Hz, 1H), 3.99 (dqd, ^{3}J = 9.1 Hz, ^{3}J = 6.9 Hz, ^{3}J = 5.2 Hz, 1H), 7.44 (pseudo-d, 2H), 7.94 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 21.60, 31.24, 35.06, 35.50, 49.06, 125.53, 127.58, 127.70, 152.63, 155.44, 166.54. IR (liquid film): 1670, 1791 cm^{-1}. HRMS (EI) calculated 245.14158; measured 245.14234, fit 3.1 ppm.

4-Ethyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3b**): Passed thru silica gel using 2:1 hexanes:ethyl acetate (R_f = 0.25). ^{1}H NMR (δ, $CDCl_3$): 1.07 (t, ^{3}J = 7.2 Hz, 3H), 1.34 (s, 9H), 1.70 (m, 2H), 2.42 (dd, ^{3}J = 9.8 Hz, ^{2}J = 15.9 Hz, 1H), 2.75 (dd, ^{3}J = 5.2 Hz, ^{2}J = 15.9 Hz, 1H), 3.76 (ddt, ^{3}J = 5.2 Hz, ^{3}J = 6.5 Hz, ^{3}J = 9.8 Hz, 1H), 7.44 (pseudo-d, 2H), 7.90 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.19, 28.84, 31.22, 33.40, 35.04, 125.48,

127.57, 127.69, 152.45, 155.35, 166.68. IR (liquid film): 1673, 1790 cm^{-1}. HRMS (EI): calculated 259.15723, measured 259.15818, fit 3.7 ppm.

(4*R*)-4-Ethyl-2-(4-*tert*-butylphenyl)-2-oxazinone ((*R*)-**3b**): Passed through silica gel using 2:1 Hexanes:Ethyl acetate (R_f = 0.25). ^{1}H NMR (δ, $CDCl_3$): 1.08 (t, ^3J = 7.5 Hz, 3H), 1.34 (s, 9H), 1.70 (m, 2H), 2.42 (dd, ^2J = 16.2 Hz, ^3J = 9.9 Hz, 1H), 2.75 (dd, ^2J = 16.2 Hz, ^3J = 5.1 Hz, 1H), 3.76 (ddt, ^3J = 9.9 Hz, ^3J = 5.4 Hz, ^3J = 6.6 Hz, 1H), 7.44 (pseudo-d, 2H), 7.95 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.16, 28.82, 31.19, 33.36, 35.00, 54.46, 125.45, 127.56, 127.70, 152.41, 155.30, 166.82. IR (liquid film): 1673, 1791 cm^{-1}. HRMS (EI) calculated 259.15723; measured 259.15724, fit 0.1 ppm.

4-(2-Methyl)propyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3c**): Recrystallized from pentane at –20 °C. ^{1}H NMR (δ, $CDCl_3$): 0.98 (d, ^3J = 6.6 Hz, 3H), 0.99 (d, ^3J = 6.6 Hz, 3H), 1.33 (s, 9H), 1.37 (m, 1H), 1.62 (ddd, ^3J = 6.3 Hz, ^3J = 8.4 Hz, ^2J = 13.5 Hz, 1H), 1.98 (ddd, ^3J = 6.9 Hz, 1H), 2.38 (dd, ^3J = 9.3 Hz, ^2J = 15.9 Hz, 1H), 2.74 (dd, ^3J = 5.1 Hz, ^2J = 15.9 Hz, 1H), 3.91 (m, 1H), 7.43 (pseudo-d, 2H), 7.95 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 22.45, 22.82, 24.69, 31.16, 34.16, 34.95, 44.94, 51.26, 125.40, 127.51, 127.72, 152.18, 155.21, 166.63. IR (liquid film): 1671, 1791 cm^{-1}. HRMS (EI) calculated 287.18853; measured 287.18728, fit –4.3 ppm.

(4*S*)-4-(2-Methyl)propyl-2-(4-*tert*-butylphenyl)-2-oxazinone ((*S*)-**3c**): Passed through silica gel using CH_2Cl_2 (R_f = 0.47). ^{1}H NMR (δ, $CDCl_3$): 0.98 (d, ^3J = 6.6 Hz, 3H), 0.99 (d, ^3J = 6.6 Hz, 3H), 1.33 (s, 9H), 1.37 (m, 1H), 1.60 (m, 1H), 1.97 (m, 1H), 2.39 (dd, ^3J = 9.3 Hz, ^2J = 16.2 Hz, 1H), 2.75 (dd, ^3J = 5.9 Hz, ^2J = 15.9 Hz, 1H), 3.92 (m, 1H), 7.44 (pseudo-d, 2H), 7.94 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 22.53, 22.87, 24.78, 31.25, 34.26, 35.06, 45.01, 51.36, 125.51, 127.58, 127.76, 152.29, 155.35, 166.81. IR (liquid film): 1673, 1786 cm^{-1}. HRMS (EI) calculated 287.18853; measured 287.18969, fit 4.1 ppm.

4-Benzyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3d**): Recrystallized from pentane. ^{1}H NMR (δ, $CDCl_3$): 1.34 (s, 9H), 2.40 (dd, ^3J = 9.3 Hz, ^2J = 16.0 Hz, 1H), 2.66 (dd, ^3J = 5.5 Hz, ^2J = 16.0 Hz, 1H), 2.83 (dd, ^3J = 8.1 Hz, ^2J = 13.5 Hz, 1H), 3.16 (dd, ^3J = 5.5 Hz, ^2J = 13.5 Hz, 1H), 4.11 (ddt, ^3J = 5.5 Hz, ^3J = 8.1 Hz, ^3J = 9.3 Hz), 7.27 (m, 5H), 7.45 (pseudo-d, 2H), 7.95 (m, 5H). ^{13}C NMR (δ, $CDCl_3$): 31.24, 32.80, 35.08, 41.70, 54.64, 125.56, 126.99, 127.58, 127.63, 128.69, 129.69, 137.12, 152.93, 155.53, 166.41. IR (liquid film): 1671, 1789 cm^{-1}. HRMS (EI) calculated 321.1729, measured 321.1739, fit 3.2 ppm.

4-(*tert*-Butyldimethylsiloxymethyl)-2-(4-*tert*-butylphenyl)-2-oxazinone (**3e**): Passed through a plug of silica gel using 2:1 hexanes:ethyl acetate (R_f = 0.25). ^{1}H NMR (δ, $CDCl_3$): 0.01 (s, 3H), 0.05 (s, 3H), 0.85 (s, 9H), 1.34 (s, 9H), 2.65 (dd, ^3J = 6.0 Hz, ^2J = 16.2 Hz, 1H), 2.78 (dd, ^3J = 6.3 Hz, ^2J = 16.2 Hz, 1H), 3.84 (d, ^3J = 3.6 Hz, 2H), 3.99 (m, 1H), 7.43 (pseudo-d, 2H), 7.93 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): -5.51, -5.45, 18.29, 25.82, 25.95, 31.25, 35.05, 55.48, 65.94, 125.47, 127.59, 127.89, 153.98, 155.29, 166.30. IR (liquid film): 1673, 1793 cm^{-1}. MS (CI) (*m*/*z*): 376.1 (M^+). HRMS (EI) (M^+-57): calculated 318.15255; measured 318.15327, 2.3 ppm. The molecular ions of TBDMS ethers are difficult to observe.[10]

4-Isopropyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3f**): Passed through silica gel using CH_2Cl_2 (R_f = 0.73). ^{1}H NMR (δ, $CDCl_3$): 1.03 (d, ^3J = 6.9, 3H), 1.06 (d, ^3J = 6.9 Hz, 3H), 1.34 (s, 9H), 1.92 (apparent octet, ^3J = 6.6 Hz, 1H), 2.41 (dd, ^3J = 11.3 Hz, ^2J = 16.2 Hz, 1H), 2.72 (dd, ^3J = 5.3 Hz, ^2J = 16.2 Hz, 1H), 3.61 (apparent pentet, ^3J = 5.7 Hz, 1H), 7.44 (pseudo-d, 2H), 7.96 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 18.49, 18.67, 31.16, 31.25, 33.05, 35.06, 58.50, 125.49, 127.60, 127.78, 152.33, 155.31, 167.41. IR (liquid film): 1675, 1790 cm^{-1}. HRMS (EI) calculated 273.17288; measured 273.17386, fit 3.6 ppm.

(4*R*)-4-Isopropyl-2-(4-*tert*-butylphenyl)-2-oxazinone ((*R*)-**3f**): Passed through silica gel using CH_2Cl_2 (R_f = 0.43). ^{1}H NMR (δ, $CDCl_3$): 1.04 (d, ^3J = 8.3 Hz, 3H), 1.06 (d, ^3J = 8.3 Hz, 3H), 1.34 (s, 9H), 1.91 (m, 1H), 2.41 (dd, ^3J = 11.1 Hz, ^2J = 16.1 Hz,1H), 2.72 (dd, ^3J = 5.1 Hz, ^2J = 16.1 Hz, 1H), 3.61 (m, 1H), 7.44 (pseudo-d, 2H), 7.96 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 18.49, 18.69, 31.18, 31.26, 33.07, 35.06, 58.52, 125.50, 127.61, 127.81, 152.33, 155.32, 167.41. IR (liquid film): 1675, 1790 cm^{-1}. HRMS (EI) calculated 273.1729, measured 273.1728, fit -0.3 ppm.

4-Phenyl-2-(4-*tert*-butylphenyl)-2-oxazinone (**3g**): Recrystallized from diethyl ether and washed with pentane. ^{1}H NMR (δ, $CDCl_3$): 1.36 (s, 9H), 2.65 (dd, ^3J = 10.8 Hz, ^2J = 16.0 Hz, 1H), 3.06 (dd, ^3J = 5.2 Hz, ^2J = 16.0 Hz, 1H), 5.06 (dd, ^3J = 5.2 Hz, ^3J = 10.8 Hz, 1H), 7.35 (m, 3H), 7.40 (pseudo-d, 2H), 7.48 (pseudo-d, 2H), 8.06 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.26, 35.12, 36.49, 56.63, 125.61, 126.33, 127.50, 127.86, 127.97, 129.03, 140.78, 153.81, 155.79, 165.86. IR (liquid film): 1671, 1792 cm^{-1}. HRMS (EI) calculated 307.15723; measured 307.15809, fit 2.8 ppm.

(4*R*)-4-Phenyl-2-(4-*tert*-butylphenyl)-2-oxazinone ((*S*)-**3g**): Recrystallized from diethyl ether and washed with pentane. ^{1}H NMR (δ, $CDCl_3$): 1.35 (s, 9H), 2.65 (dd, ^2J = 15.9 Hz, ^3J = 10.8 Hz, 1H), 3.06 (dd, ^2J = 15.9 Hz, ^3J = 5.1 Hz, 1H), 5.06 (dd, ^3J = 5.1 Hz, ^3J = 10.8 Hz, 1H), 7.34 (m, 1H), 7.40 (m, 4H), 7.47 (pseudo-d, 2H), 8.05 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 31.26, 35.13, 36.50, 56.63, 125.61, 126.34, 127.50, 127.86, 127.98, 129.03, 140.78, 153.82, 155.80, 165.87. IR (liquid film): 1672, 1790 cm^{-1}. HRMS (EI) calculated 307.15723; measured 307.15840, fit 3.8 ppm.

5-Methyl-2-(4-tert-butylphenyl)-2-oxazinone (**3h**): ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.43 (d, ^3J = 6.0 Hz, 3H), 2.69 (m, 1H), 3.51 (dd, ^3J = 12.3 Hz, ^2J = 15.9 Hz, 1H), 3.91 (dd, ^3J = 6.6 Hz, ^2J = 15.9 Hz, 1H), 7.44 (pseudo-d, 2H), 7.92 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 12.65, 31.34, 33.68, 35.19, 49.66, 125.68, 127.62, 128.12, 154.40, 155.63, 169.95. IR (liquid film): 1676, 1786 cm^{-1}. HRMS (m/z) calculated 245.14158, measured 245.14047, fit -4.5 ppm.

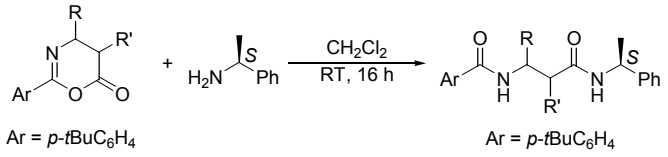
(5*S*)-5-Methyl-2-(4-*tert*-butylphenyl)-2-oxazinone ((*S*)-**3h**): ^{1}H NMR (δ, $CDCl_3$): 1.33 (s, 9H), 1.34 (br s, 3H), 2.69 (d-pentet, ^3J = 6.6 Hz, ^2J = 12.6 Hz, 1H), 3.50 (dd, ^3J = 12.3 Hz, ^2J = 16.2 Hz, 1H), 3.90 (dd, ^3J = 6.9, ^2J = 16.2 Hz, 1H), 7.44 (pseudo-d, 2H), 7.92 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 12.66, 31.18, 33.67, 35.19, 49.77, 125.68, 127.61,

127.67, 152.21, 155.60, 170.01. IR (liquid film): 1639, 1814 cm^{-1}. HRMS (m/z) calculated 245.1424, measured 245.1416, fit -3.4 ppm.

Reaction of oxazinone with (*S*)-(-)-α-methylbenzylamine.

After the standard workup, the crude carbonylation reaction mixture of (*R*)-**3e** was dissolved in 5 mL CH_2Cl_2 and stirred at 22 °C. To this was added (*S*)-(-)-α-methylbenzylamine (141.1 mg, 1.164 mmol, 1.16 eq) dropwise and the reaction mixture was stirred overnight. The mixture was concentrated under reduced pressure and analyzed by ^{1}H NMR spectroscopy. Upon completion, the residue was combined with 10 mL Et_2O and filtered through qualitative filter paper. The white powder was washed with 10 mL Et_2O and dried under reduced pressure. For the diastereomeric mixture of (*R*,*S*)- and (*S*,*S*)-**4h**, the reaction mixture was dried under reduced pressure and purified by column chromatography using hexanes:ethyl acetate (1:1). The ^{1}H and ^{13}C NMR spectra for the stereopure and stereoisomeric samples were compared and the diastereomeric ratio was determined by integration of the corresponding peaks for each diastereomer. X-ray quality crystals of (*R*,*S*)-**4f** (Figure S4) and (*S*,*S*)-**4h** (Figure S5) were each grown

Table S2. Determination of Diastereomeric Ratios of Oxazinones.[a]



Ar = *p*-*t*BuC$_6$H$_4$ (**3**) Ar = *p*-*t*BuC$_6$H$_4$ (**4**)

Entry	R	R'	Oxazinone	Diastereomeric Ratio of **4**[b] (*R*,*S*) : (*S*,*S*)
1	Et	H	(*rac*)-**3b**	1 : 1
2	Et	H	(*R*)-**3b**	>99 : 1
3	iBu	H	(*rac*)-**3c**	1 : 1
4	iBu	H	(*S*)-**3c**	1 : >99
5	iPr	H	(*rac*)-**3f**	1 : 1
6	iPr	H	(*R*)-**3f**	>99 : 1
7	Ph	H	(*rac*)-**3g**	1 : 1
8	Ph	H	(*S*)-**3g**	1 : >99
9	H	Me	(rac)-**3h**	1 : 1
10	H	Me	(S)-**3h**	1 : >99

[a] Oxazinones were derivatized according to the above procedure. [b] Determined by ^{1}H NMR spectroscopy by integration of the requisite peaks for *N*-(*S*)-α-methylbenzyl 3-(4-*tert*-butylbenzamido)alkanamides.

separately by slow evaporation of methanol solutions.

The diastereomeric ratios of the β-benzamido alkanamides produced by this method are summarized in Table S2.

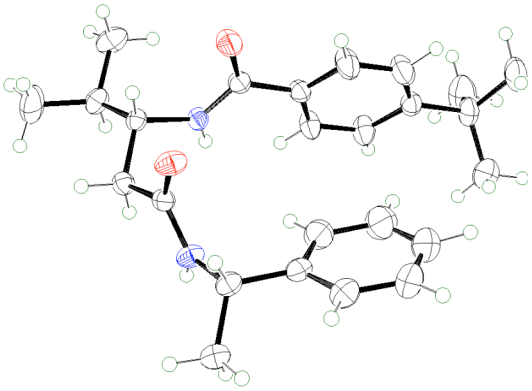


Figure S4. Molecular structure of (*R*,*S*)-**4f**. Thermal ellipsoids are drawn at the 40% probability level.

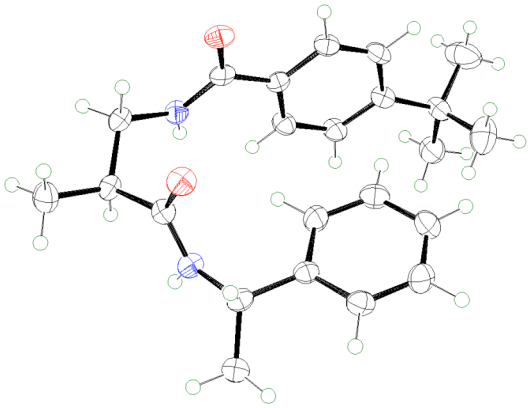


Figure S5. Molecular structure of (*S*,*S*)-**4h**. Thermal ellipsoids are drawn at the 40% probability level.

Characterization of *N*-(*S*)-α-Methylbenzyl 3-(4-*tert*-butylbenzamido)alkanamides.

N-(*S*)-α-Methylbenzyl 3-(4-*tert*-butylbenzamido)pentanamide ((*R*,*S*)-**4b** / (*S*,*S*)-**4b**): ^{1}H NMR (δ, $CDCl_3$): 0.93 (t, ^{3}J = 7.5 Hz, 3H), 0.98 (t, ^{3}J = 7.2 Hz, 3H), 1.33 (s, 18H), 1.44 (d, ^{3}J = 6.9 Hz, 3H), 1.49 (d, ^{3}J = 6.9 Hz, 3H), 1.68 (m, 4H), 2.46 (m, 2H), 2.60 (dd, ^{3}J = 4.2 Hz, ^{2}J = 15.0 Hz, 2H), 4.30 (m, 2H), 5.11 (pentet, ^{3}J = 7.2 Hz, 2H), 6.31 (br s, 2H), 7.2-7.3 (m, 5H), 7.42 (pseudo-d, 2H), 7.44 (pseudo-d, 2H), 7.70 (pseudo-d, 2H), 7.75 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 10.94, 10.97, 22.05, 27.54, 27.64, 31.25, 34.97, 40.15, 40.32, 48.57, 48.63, 48.91, 49.01, 125.48, 125.53, 126.15, 126.20, 126.95, 127.30, 127.34, 128.65, 128.72, 131.56, 131.60, 143.21, 143.32, 154.95, 154.98, 167.23, 167.27, 170.63.

N-(*S*)-α-Methylbenzyl (3*R*)-3-(4-*tert*-butylbenzamido)pentanamide ((*R*,*S*)-**4b**): ^{1}H NMR (δ, $CDCl_3$): 0.98 (t, ^{3}J = 7.2 Hz, 3H), 1.33 (s, 18H), 1.49 (d, ^{3}J = 6.9 Hz, 3H), 1.70 (m, 2H), 2.45 (dd, ^{3}J = 5.7 Hz, ^{2}J = 15.3 Hz, 1H), 2.59 (dd, ^{3}J = 4.8 Hz, ^{2}J = 15.3 Hz, 1H), 4.30 (m, 1H), 5.11 (pentet, ^{3}J = 7.2 Hz, 1H), 6.29 (d, ^{3}J = 7.5 Hz, 1H), 7.1-7.3 (m, 5H), 7.42 (pseudo-d, 2H), 7.69 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 11.04, 22.00, 27.59, 31.28, 35.00, 40.14, 48.63, 49.04, 125.54, 126.22, 126.92, 127.44, 128.76, 131.61, 143.03, 154.98, 167.16, 170.51.

N-(*S*)-α-Methylbenzyl 6-methyl-3-(4-*tert*-butylbenzamido)heptanamide ((*R*,*S*)-**4c** / (*S*,*S*)-**4c**): ^{1}H NMR (δ, $CDCl_3$): 0.84 (d, ^{3}J = 6.9 Hz, 3H), 0.85 (d, ^{3}J = 6.9 Hz, 3H), 0.89 (d, ^{3}J = 6.0 Hz, 3H), 0.91 (d, ^{3}J = 6.0, 3H), 1.33 (s, 18H), 1.38 (d, ^{3}J = 6.9 Hz, 3H), 1.45 (d, ^{3}J = 6.9 Hz, 3H), 1.60 (m, 2H), 2.37 (dd, ^{3}J = 6.0 Hz, ^{3}J = 15.3 Hz, 2H), 2.52 (dd, ^{3}J = 4.5 Hz, ^{3}J = 15.3 Hz, 2H), 2.54 (dd, ^{3}J = 4.5 Hz, ^{3}J = 15.3 Hz, 1H), 4.43 (m, 2H), 5.06 (pentet, ^{3}J

= 7.2 Hz, 2H), 6.44 (m, 2H), 7.1-7.3 (m, 6H), 7.37 (pseudo-d, 2H), 7.39 (pseudo-d, 2H), 7.65 (pseudo-d, 2H), 7.70 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 22.03, 22.06, 22.31, 22.37, 22.93, 23.05, 25.27, 25.31, 31.27, 34.99, 41.03, 41.11, 43.49, 43.64, 45.17, 45.24, 48.93, 49.04, 125.53, 125.57, 126.17, 126.22, 126.95, 128.70, 128.76, 131.52, 131.57, 143.15, 143.35, 155.03, 167.03, 170.58.

N-(*S*)-α-Methylbenzyl (3*S*)-6-methyl-3-(4-*tert*-butylbenzamido)heptanamide ((*S*,*S*)-**4c**): ^{1}H NMR (δ, $CDCl_3$): 0.89 (d, ^3J = 6.0 Hz, 3H), 0.90 (d, ^3J = 6.0, 3H), 1.33 (s, 18H), 1.43 (d, ^3J = 6.9 Hz, 3H), 1.62 (m, 1H), 2.45 (dd, ^3J = 6.0 Hz, ^3J = 15.3 Hz, 1H) 2.59 (dd, ^3J = 4.5 Hz, ^3J = 15.3 Hz, 1H), 4.46 (m, 1H), 5.11 (pentet, ^3J = 7.2 Hz, 1H), 6.36 (d, ^3J = 7.8 Hz, 1H), 7.20-7.36 (m, 6H), 7.43 (pseudo-d, 2H), 7.74 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 21.98, 22.32, 25.29, 31.27, 35.00, 41.09, 43.50, 45.34, 48.94, 125.58, 126.16, 126.92, 127.43, 128.77, 131.59, 143.31, 155.04, 167.01, 170.55.

N-(*S*)-α-Methylbenzyl 4-methyl-3-(4-*tert*-butylbenzamido)pentanamide ((*R*,*S*)-**4f** / (*S*,*S*)-**4f**): ^{1}H NMR (δ, $CDCl_3$): 0.94 (d, ^3J = 6.9 Hz, 3H), 0.95 (d, ^3J = 6.9 Hz, 3H), 0.98 (d, ^3J = 6.9 Hz, 3H), 1.00 (d, ^3J = 6.9 Hz, 3H), 1.33 (s, 18H), 1.42 (d, ^3J = 6.9 Hz, 3H), 1.49 (d, ^3J = 6.9 Hz, 3H), 1.94 (m, 1H), 2.56 (m, 2H), 4.17 (m, 1H), 5.09 (m, 1H), 6.46 (br s, 1H), 7.22-7.33 (m, 12H), 7.42 (pseudo-d, 2H), 7.45 (pseudo-d, 2H), 7.69 (pseudo-d, 2H), 7.75 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 19.24, 19.28, 19.75, 22.03, 31.27, 32.05, 32.13, 35.00, 38.53, 38.85, 48.96, 49.06, 52.42, 52.51, 125.54, 125.60, 126.20, 126.22, 126.95, 126.97, 127.30, 127.38, 128.66, 128.75, 131.57, 131.62, 143.18, 143.32, 155.03, 155.07, 167.40, 167.41, 170.61.

N-(*S*)-α-Methylbenzyl (3*R*)-4-methyl-3-(4-*tert*-butylbenzamido)pentanamide ((*R*,*S*)-**4f**): ^{1}H NMR (δ, $CDCl_3$): 0.94 (d, ^3J = 6.9 Hz, 3H), 0.95 (d, ^3J = 6.9, 3H), 1.33 (s, 18H), 1.41 (d, ^3J = 7.2 Hz, 3H), 1.93 (sextet, ^3J = 6.9 Hz, 2H), 2.53 (dd, ^3J = 6.9 Hz, ^3J = 15.6 Hz, 1H) 2.60 (dd, ^3J = 4.8 Hz, ^3J = 15.6 Hz, 1H), 4.15 (m, 1H), 5.09 (quintet, ^3J = 7.2 Hz, 1H), 6.51 (d, ^3J = 7.8 Hz, 1H), 7.22-7.36 (m, 6H), 7.44 (pseudo-d, 2H), 7.75 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 19.24, 19.75, 22.00, 31.27, 32.06, 35.01, 38.89, 48.99, 52.59, 125.63, 126.20, 126.94, 127.40, 128.76, 131.63, 143.28, 155.09, 167.43, 170.63.

N-(*S*)-α-Methylbenzyl 3-phenyl-3-(4-*tert*-butylbenzamido)propanamide ((*R*,*S*)-**4g** / (*S*,*S*)-**4g**): ^{1}H NMR (δ, $CDCl_3$): 1.26 (d, ^3J = 7.2 Hz, 3H), 1.33 (s, 18H), 1.42 (d, ^3J = 6.9 Hz, 3H), 2.64 (dd, ^3J = 5.1 Hz, ^2J = 14.4 Hz, 1H), 2.69 (dd, ^3J = 5.1 Hz, ^2J = 14.4 Hz, 1H), 2.85 (dd, ^3J = 4.8 Hz, ^2J = 14.4 Hz, 1H), 2.90 (dd, ^3J = 4.8 Hz, ^2J = 14.4 Hz, 1H), 5.04 (sextet, ^3J = 7.5 Hz, 2H), 5.53 (m, 2H), 5.89 (d, ^3J = 6.6 Hz, 1H), 5.97 (d, ^3J = 6.9 Hz, 1H), 6.95 (m, 2H), 7.2-7.4 (m, 10H), 7.45 (pseudo-d, 2H), 7.46 (pseudo-d, 2H), 7.82 (pseudo-d, 2H), 7.83 (pseudo-d, 2H), 8.53 (d, ^3J = 7.8 Hz, 1H), 8.60 (d, ^3J = 7.8 Hz, 1H). ^{13}C NMR (δ, $CDCl_3$): 21.42, 21.58, 31.28, 35.01, 42.06, 42.22, 48.70, 48.95, 50.67, 50.79, 125.58, 126.01, 126.23, 127.12, 127.29, 127.42, 127.57, 128.64, 128.74, 128.79, 131.34, 140.97, 141.13, 142.39, 142.56, 155.10, 166.53.

N-(*S*)-α-Methylbenzyl (3*S*)-3-phenyl-3-(4-*tert*-butylbenzamido)propanamide ((*S*,*S*)-**4g**): ^{1}H NMR (δ, $CDCl_3$): 1.20 (d, ^3J = 6.9 Hz, 3H), 1.33 (s, 18H), 2.60 (dd, ^3J = 5.7 Hz, ^2J = 14.4 Hz, 1H), 2.68 (dd, ^3J = 5.1 Hz, ^2J = 14.4 Hz, 1H), 4.97 (pentet, ^3J = 7.2 Hz, 1H),

5.43 (m, 1H), 6.87 (d, ^3J = 7.8 Hz, 1H), 7.0-7.3 (m, 10H), 7.39 (pseudo-d, 2H), 7.79 (pseudo-d, 2H), 8.74 (d, ^3J = 7.8 Hz, 1H). ^{13}C NMR (δ, $CDCl_3$): 21.49, 31.19, 34.89, 41.72, 48.70, 50.85, 125.42, 126.19, 126.23, 126.54, 127.12, 127.23, 127.29, 127.41, 128.51, 128.56, 131.28, 141.29, 142.90, 154.92, 166.64, 170.32.

N-(*S*)-α-Methylbenzyl 2-methyl-3-(4-*tert*-butylbenzamido)propanamide ((*R,S*)-**4h** / (*S,S*)-**4h**): ^{1}H NMR (δ, CD_3OD): 1.08 (d, ^3J = 6.9 Hz, 3H), 1.13 (d, ^3J = 6.9 Hz, 3H), 1.29 (s, 18H), 1.34 (d, ^3J = 3.6 Hz, 3H), 1.36 (d, ^3J = 3.6 Hz, 3H), 2.79 (m, 2H), 3.39 (m, 4H), 7.02 (pseudo-d, 2H), 7.16 (pseudo-d, 2H), 7.25 (m, 6H), 7.40 (pseudo-d, 2H), 7.45 (pseudo-d, 2H), 7.60 (pseudo-d, 2H), 7.72 (pseudo-d, 2H). ^{13}C NMR (δ, CD_3OD): 15.88, 15.94, 22.46, 22.56, 31.56, 35.74, 41.56, 44.14, 44.33, 49.92, 126.45, 126.91, 126.98, 127.73, 127.96, 128.14, 128.18, 129.39, 129.45, 130.57, 132.53, 132.63, 145.23, 156.23, 156.33, 170.19, 170.27, 176.46, 176.59.

N-(*S*)-α-Methylbenzyl (2*S*)-2-((4-tert-butylbenzamido)methyl)propanamide ((*S,S*)-**4h**): ^{1}H NMR (δ, $CDCl_3$): 1.21 (d, ^3J = 6.9 Hz, 3H), 1.34 (s, 18H), 1.44 (d, ^3J = 6.9 Hz, 3H), 2.76 (m, 1H), 3.40 (ddd, 2J = 13.6 Hz, ^3J = 8.6 Hz, ^3J = 5.6 Hz, 1H), 3.63 (ddd, ^2J = 13.6 Hz, ^3J = 6.3 Hz, ^3J = 4.5 Hz, 1H), 5.08 (pentet, ^3J = 6.9 Hz, 1H), 6.26 (d, ^3J = 7.8 Hz, 1H), 6.82 (s, 1H), 7.08 - 7.20 (m, 5H), 7.37 (pseudo-d, 2H), 7.56 (pseudo-d, 2H). ^{13}C NMR (δ, $CDCl_3$): 15.853, 22.075, 31.269, 34.994, 40.835, 43.134, 48.853, 125.541, 125.986, 126.892, 127.162, 128.654, 131.386, 143.430, 154.982, 167.833, 174.557.

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