SUPPORTING INFORMATION

Enantioselective Addition of Nitrones to Activated Cyclopropanes

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General Experimental Procedures. Methylene chloride was distilled from calcium hydride prior to use. $Ni(ClO_4)_2\,6H_2O$ was used as received from Strem. The other Lewis acids were purchased form Aldrich or Strem. Activated molecular sieves Powder 4A (MS 4A) was purchased from Aldrich and dried at 250-300 °C under vacuum before use. The cyclopropyl malonates **1a** and **1b** were used as received from Aldrich. The cyclopropyl malonate **1c** was prepared from t-butyl malonate and 1,2-dibromoethane in dry DMF using K_2CO_3 as base in low yield and the reaction was not optimized. The cyclopropyl malonate **1d** was prepared with methyl malonate and 1,2-dibromopropane in dry DMF using K_2CO_3 as base in low yield (30-50%) and the reaction was not optimized. The cyclopropyl malonates **1e** and **1f** were synthesized according to literature procedure.[1] The nitrones **2a-g** were synthesized using *N*-methylhydroxylamine hydrochloride or *N*-benzylhydroxylamine with corresponding aldehyde according to the literature.[2] Diphenyl nitrone **2d** was used as received from Lancaster. The ligands **4a-d**[3] and **4g**[4] were synthesized according to literature procedure. Ligand **4f** was synthesized according to the method reported by our laboratory.[5] Flash chromatography was performed using EM Science silica gel 60 (230-400 mesh). All glassware was oven dried, assembled hot, and cooled under a stream of dry nitrogen before use. Reactions with air sensitive materials were carried out by standard syringe techniques.

Melting points were recorded on a Fisher-Johns melting point apparatus and are uncorrected. ^{1}H NMR was recorded on a Varian Unity/Inova-500 NB (500 MHz), or a Varian Mercury-400 (400 MHz). Chemical shifts are reported in parts per million (ppm) down field from TMS, using residual $CDCl_3$ (7.27 ppm) or C_6D_6 (7.15 ppm) as an internal standard. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, qn = quintet, dd = doublets of doublets, dt = doublets of triplets, dq = doublets of quartets, m = multiplet, br = broad, AB sys = AB system), coupling constant(s) and integration. ^{13}C NMR was recorded on a Varian Unity/Inova-500 NB (125 MHz) or a Varian Mercury-400 (100 MHz) spectrometers using broad band proton decoupling. Chemical shifts are reported in parts per million (ppm) down field from TMS, using the middle resonance of $CDCl_3$ (77.23 ppm) as an internal standard. HPLC analyses were carried out on Waters 515 HPLC pump and a 2487 dual λ absorbance detector connected to a PC with millennium workstation. Rotations were recorded on a JASCO-DIP-370 instrument. High-resolution mass spectra (HRMS) [EI+ or FAB] were obtained from the Mass Spectrometry Laboratory, Ohio State University, Columbus, Ohio.

General Rationale for the Assignment of Regioselectivity: Regioselectivity is consistent with that observed by Kerr for analogous reactions, and the NMR spectra for products **3b** and **3n** match those for known compounds.[6] In addition, ^{1}H NMR for products **3a-i** and **3k-n** shows a 1H singlet for the benzylic hydrogen, which would not be expected for the opposite regioisomers in which the oxygen end of the nitrone attached to the malonate carbon. The regioselectivity of the reaction in which **3l** and **3m** are formed is assigned based on analogy with **3n**, and on the ^{1}H-NMR chemical shifts for the

methylene hydrogens. The regioselectivity for **3o** and **3p** is also assigned based on the ^{1}H-NMR chemical shifts for the methylene hydrogens.

General procedure for the preparation of the racemic samples: A modified literature procedure was used.[6] A flame-dried vial was charged with $Yb(OTf)_3$-xH_2O (0.090 mmol), freshly dried 4A molecular sieves (150 mg) and substrate (0.30 mmol), and dry CH_2Cl_2 (1.5 mL) and dry THF (1.5 mL) were added. The mixture was then stirred at room temperature for 15 min before nitrone (0.45 mmol) was added. The solution was then stirred at room temperature for 1 to 3 days (TLC). The reaction mixture was then filtered through a 35 mm layer of silica gel (7g). The silica gel layer was washed with 40-60 mL of Et_2O (TLC). The solvent was removed under reduced pressure to give the crude product, which was separated by FC (silica gel, hexane/ethyl acetate 95:5-80:20), giving standard racemic samples. When 2-substitutated cyclopropyl substrates were used, the less polar isomer was the *trans*-isomer, and the more polar compound was the *cis*-isomer. Generally, *cis* isomers were the major products and both *cis* and *trans* isomers could be obtained in analytically pure form using this method.

Enantioselective Nitrone Cycloadditions with Cyclopropyl Malonates

General procedure for the enantioselective nitrone cycloadditions with cyclopropyl malonates: A flame-dried vial was charged with $Ni(ClO_4)_2$-$6H_2O$ (or other Lewis acid) (0.090 mmol) and the corresponding ligand (0.099 mmol) and 150-250 mg freshly dried 4A molecular sieves was added. (For reactions shown in Table 3, 0.030 mmol of $Ni(ClO_4)_2$-$6H_2O$ and 0.033 mmol of ligand **4g** were used.) Dry CH_2Cl_2 (3 mL) was added under nitrogen, and the mixture was then stirred at room temperature overnight (or 2 hours), till all $Ni(ClO_4)_2$-$6H_2O$ (or other Lewis acid) was dissolved. To the pale green

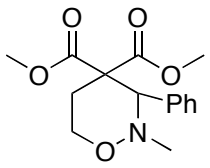
solution, cyclopropyl substrate **1** (0.30 mmol) in 0.3 mL dry CH_2Cl_2 was added via syringe and then the reaction mixture changed slightly to a darker blue/green. After the mixture was stirred at room temperature for 15 min, nitrone **2** (0.40 mmol) was added. An immediate color change to a more yellow/green was normally observed. The solution was then stirred at room temperature for the appropriate time. The starting cyclopropanes **1** normally did not show up very easily by TLC, so conservatively long times were normally used. The reaction mixture was then filtered through a 35 mm layer of silica gel (7g). The silica gel layer was washed with 40-60 mL of Et_2O (TLC). The solvent was removed under reduced pressure to give the crude product, which was used to determine the diastereomer ratio (for products **3l-n**) with ^{1}H NMR, comparing to the data of the standard *trans* and *cis* samples. The diastereomers were separated by FC (silica gel, hexane/ethyl acetate 95:5-80:20). The *ee* was estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel OD or AD column with hexane/*i*-PrOH as eluent). The absolute stereochemistry for the tetrahydro-1,2-oxazine products has not been established.

Relative rate study, for the reaction of cyclopropanes 1a,b,d,e,f with nitrone 2a using the general procedure for the enantioselective nitrone cycloadditions

The general procedure (see above) was used. At time intervals, 0.2-mL aliquots were removed, diluted to 1 mL with $CDCl_3$, and analyzed by ^{1}H NMR. Integration was used to monitor conversion. For substrates **1a**, **1b**, **1d**, and **1e**, the reactions were clean, so integration of starting material and product was uncomplicated. For **1f**, side products were observed in addition to product, so measurement of conversion is less precise.

Substrate	% Conversion after Indicated Time					
	20 min	1h	2h	8h	24h	48h
1a	-	-	20%	60%	96%	100%
1a in THF	-	-	15%	60%	95%	100%
1b	-	-	20%	60%	97%	100%
1d	-	-	92%	100%	-	-
1d in THF	-	-	60%	90%	100%	-
1e	80%	97%	100%	-	-	-
1e in THF	-	-	100%	-	-	-
1f	70%	~97%	100%	-	-	-

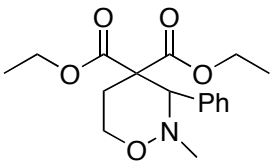
2-Methyl-3-phenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3a).



3a

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 2 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.26 (dt, J = 14.5 Hz, 2.5 Hz, 1H), 2.43 (s, 3H), 2.65 (ddd, J = 14.5 Hz, 13.5 Hz, 5.0 Hz, 1H), 3.38 (s, 3H), 3.82 (s, 3H), 3.94 (dt, J = 3.0 Hz, 12.0 Hz, 1H), 4.19 (br s, 1H), 4.68 (s, 1H), 7.28-7.30 (m, 3H), 7.52-7.53 (m, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 25.7, 43.8, 52.5, 53.3, 58.2, 66.7, 69.7, 128.1, 128.4, 131.0, 135.3, 168.9, 170.5. $[\alpha]_D^{25}$ = +199.1 (*c* 1.0, $CHCl_3$), 90% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 18.2 min (major), t = 20.4 min (minor)). HRMS calcd. for $C_{15}H_{19}NO_5Na^+$ is 316.1155 and Observed = 316.1158.

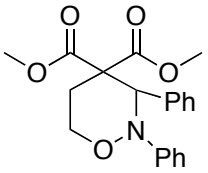
2-Methyl-3-phenyl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3b)



3b

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 1.5 days. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 0.93 (t, J = 7.2 Hz, 3H), 1.24 (t, J = 7.2 Hz, 3H), 2.23 (dt, J = 14.4 Hz, 2.4 Hz, 1H), 2.38 (s, 3H), 2.63 (ddd, J = 14.4 Hz, 11.6 Hz, 5.6 Hz, 1H), 3.72 (dq, J = 10.8 Hz, 7.2 Hz, 1H), 3.84 (dq, J = 10.8 Hz, 7.2 Hz, 1H), 3.92 (dt, J = 3.2 Hz, 11.6 Hz, 1H), 4.13–4.18 (br dm, 1H), 4.25 (q, J= 7.2 Hz, 2H), 4.65 (s, 1H), 7.23-7.26 (m, 3H), 7.49-7.51 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 13.8, 14.2, 25.9, 43.7, 58.0, 61.5, 62.0, 66.7, 69.5, 128.0, 128.3, 131.1, 135.4, 168.6, 170.0. $[\alpha]_D^{25}$ = +172.4 (*c* 1.0, $CHCl_3$), 92% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 15.5 min (major), t = 20.1 min (minor)). HRMS calcd. for $C_{17}H_{23}NO_5Na^+$ is 344.1474: observed: 344.1512

2,3-Diphenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3d)

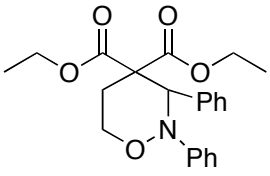


3d

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 1.5days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.44 (dt, J = 14.5 Hz, 1.5 Hz, 1H), 2.85 (ddd, J = 14.5 Hz, 13.0 Hz, 5.5 Hz, 1H), 3.47 (s, 3H), 3.89 (s, 3H), 3.94 (ddd, J = 13.0 Hz,

12.0 Hz, 3.0 Hz, 1H), 4.19 (dd, J= 12.0 Hz, 5.5 Hz, 1H), 5.70 (s, 1H), 6.80 – 6.83 (m, 1H), 7.03 -7.05 (m, 2H), 7.13 – 7.20 (m, 5H), 7.53 -7.57 (m, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 25.7, 52.7, 53.5, 58.6, 66.9, 67.7, 116.0, 121.8, 128.1, 128.2, 128.7, 130.7, 135.3, 148.9, 168.6, 170.2. $[\alpha]_D^{25}$ = +88.0 (*c* 1.0, $CHCl_3$), 91% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 19.8 min (major), t = 29.4 min (minor)). HRMS calcd. for $C_{20}H_{21}NO_5Na^+$ is 378.1312 and Observed = 378.1333.

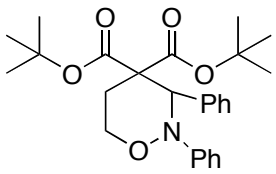
2,3-Diphenyl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3e)



3e

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 1.5 days. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 1.00 (t, J = 7.2 Hz, 3H), 1.31 (t, J = 7.2 Hz, 3H), 2.23 (d-qn, J = 14.4 Hz, 2.4 Hz, 1H), 2.85 (ddd, J = 14.4 Hz, 13.2 Hz, 5.6 Hz, 1H), 3.84 (dq, J = 10.8 Hz, 7.2 Hz, 1H), 3.92 (dq, J = 10.8 Hz, 7.2 Hz, 1H), 4.08 (ddd, J = 13.2 Hz, 11.6Hz, 2.8 Hz, 1H), 4.28 – 4.39 (m, 3H), 5.67 (s, 1H), 6.77 – 7.00 (m, 1H), 7.01 - 7.04 (m, 2H), 7.10 – 7.24 (m, 5H), 7.50 – 7.55 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 13.9, 14.3, 25.7, 58.4, 61.9, 62.4, 66.9, 67.8, 116.0, 121.7, 127.9, 128.1, 128.6, 130.8, 135.3, 149.0, 168.2, 169.7. $[\alpha]_D^{25}$ = +95.1 (*c* 1.0, $CHCl_3$), 94% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 15.5 min (major), t = 21.1 min (minor)). HRMS calcd. for $C_{22}H_{25}NO_5Na^+$ is 406.1630 and Observed = 406.1482

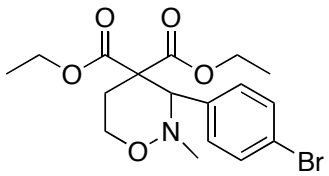
2,3-Diphenyl-[1,2]oxazinane-4,4-dicarboxylic acid ditertiary butyl ester (3f)



3f

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 3 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.19 (s, 9H), 1.55 (s, 9H), 2.36 (dm, J = 14 Hz, 1H), 2.83 (dt, J = 6.0 Hz, 14.0 Hz, 1H), 4.09 (dt, J = 2.5 Hz, 12 Hz, 1H), 4.36 (dd, J = 12.0 Hz, 5.5 Hz, 1H), 5.56 (s, 1H), 6.78 – 6.81 (m, 1H), 7.01 – 7.03 (m, 2H), 7.12 – 7.17 (m, 5H), 7.49 – 7.51 (m, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 26.3, 27.6, 28.1, 58.8, 67.2, 67.9, 82.2, 82.3, 116.0, 121.5, 127.8, 128.0, 128.6, 131.3, 135.3, 149.2, 167.4, 168.9. $[\alpha]_D^{25}$ = +59.4 (*c* 1.0, $CHCl_3$), 95% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 95/5 v/v, 0.6 mL/min, t = 29.3 min (minor), t = 33.1 min (major)). HRMS calcd. for $C_{26}H_{33}NO_5Na^+$ is 462.2251 and Observed = 462.2250.

3-(4-Bromo-phenyl)-2-methyl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3g).

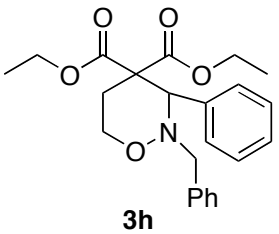


3g

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 2 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.01 (t, J = 7.5 Hz, 3H), 1.27 (t, J = 7.5 Hz, 3H), 2.26 (dt, J = 14.5 Hz, 2.5 Hz, 1H), 2.39 (s, 3H), 2.58 (ddd, J = 14.5 Hz, 11.5 Hz, 5.5 Hz, 1H), 3.79 (dq, J = 10.5 Hz, 7.0 Hz, 1H), 3.89 – 3.97 (m, 2H), 4.16 – 4.18 (br, 1H),

4.28 (q, J= 7.5 Hz, 2H), 4.64 (s, 1H), 7.40-7.44 (m, 4H). ^{13}C NMR ($CDCl_3$, 125 MHz) ẟ 13.9, 14.2, 25.9, 43.7, 57.9, 61.7, 62.2, 66.7, 68.8, 122.6, 131.2, 132.8, 134.5, 168.4, 169.8. $[\alpha]_D^{25}$ = +137.3 (*c* 1.0, $CHCl_3$), 91% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 18.8 min (major), t = 28.8 min (minor)). HRMS calcd. for $C_{17}H_{22}BrNO_5Na^+$ is 422.0574 and Observed = 422.0566.

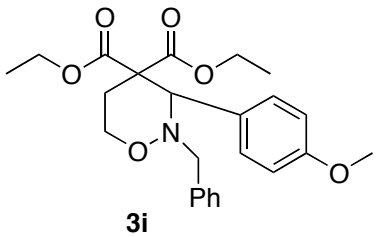
2-Benzyl-3-phenyl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3h)



3h

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 3 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 0.96 (t, J = 7.0 Hz, 3H), 1.30 (t, J = 7.0 Hz, 3H), 2.23 (d, J = 14.5 Hz, 1H), 2.72 (ddd, J = 14.5 Hz, 12.5 Hz, 6.0 Hz, 1H), 3.58 (AB Sys, J = 14.0 Hz, 1H), 3.74 - 3.80 (m, 2H), 3.86 (dq, J = 11.0 Hz, 7.5 Hz, 1H), 3.97 (dt, J = 2.5 Hz, 12.0 Hz, 1H), 4.14 (dd, J = 11.5 Hz, 5.5 Hz, 1H), 4.26 – 4.37 (m, 2H), 4.86 (s, 1H), 7.23 – 7.33 (m, 8H), 7.59 -7.60 (m, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) ẟ 13.8, 14.3, 25.7, 58.4, 59.7, 61.6, 62.0, 67.1, 67.4, 127.2, 128.1, 128.2, 128.3, 128.7, 131.3, 135.6, 137.6, 168.6, 169.9. $[\alpha]_D^{25}$ = +110.7 (*c* 1.0, $CHCl_3$), 93% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 17.3 min (major), t = 24.5 min (minor)). HRMS calcd. for $C_{23}H_{27}NO_5Na^+$ is 420.1781 and Observed = 420.1812.

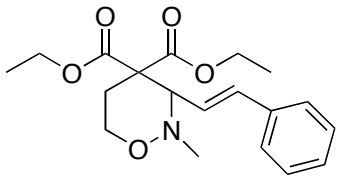
2-Benzyl-3-(4-methoxy-phenyl)-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3i)



3i

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 3days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.00 (t, J = 7.0 Hz, 3H), 1.29 (t, J = 7.0 Hz, 3H), 2.32 (d, J = 14.5 Hz, 1H), 2.69 (ddd, J = 14.5 Hz, 12.5 Hz, 5.5 Hz, 1H), 3.56 (d, AB Sys, J = 14.5 Hz, 1H), 3.73 (d AB Sys, J = 14.5 Hz, 1H), 3.77 - 3.81 (m, 1H), 3.82 (s, 3H), 3.89 (dq, J = 11.5 Hz, 7.0 Hz, 1H), 3.96 (dt, J = 2.5 Hz, 13.0 Hz, 1H), 4.12 (dd, J = 11.5 Hz, 5.5 Hz, 1H), 4.25 – 4.36 (m, 2H), 4.81 (s, 1H), 6.85 (d, J = 8.5 Hz, 2H), 7.22 – 7.31 (m, 5H), 7.51 (d, J = 8.5 Hz, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 13.9, 14.3, 25.6, 55.3, 58.5, 59.6, 61.6, 62.0, 67.1, 113.4, 127.2, 127.5, 128.2, 128.4, 128.7, 132.5, 137.7, 159.5, 168.6, 169.7. $[\alpha]_D^{25}$ = +117.3 (*c* 1.9, $CHCl_3$), 90% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 27.9 min (major), t = 31.8 min (minor)). HRMS calcd. for $C_{24}H_{29}NO_6Na^+$ is 450.1887 and Observed = 450.1887.

2-Methyl-3-styryl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3j).

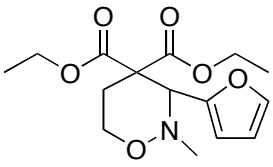


3j

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 3 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.17 (t, J = 7.0 Hz, 3H), 1.26 (t, J = 7.0 Hz,

3H), 2.26 (d, J = 14.0 Hz, 2.4 Hz, 1H), 2.38 (ddd, J = 14.0 Hz, 11.0 Hz, 5.0 Hz, 1H), 2.54 (s, 3H), 3.99 – 4.02 (m, 2H), 4.11 (m, 3H), 4.26 (m, 2H), 6.49 (dd, J= 16.0 Hz, 9.5 Hz, 1H), 6.59 (d, J = 16.0 Hz, 1H), 7.22-7.26 (m, 1H), 7.27-7.37 (m, 2H), 7.37-7.39 (m, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) ẟ 14.1, 14.2, 26.0, 43.5, 58.4, 61.7, 61.8, 67.1, 68.3, 121.6, 126.7, 128.1, 128.7, 136.5, 137.1, 168.6, 169.4. $[\alpha]_D^{25}$ = +196.73 (*c* 2.2, $CHCl_3$), 71% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 23.0 min (major), t = 31.1 min (minor)). HRMS calcd. for $C_{19}H_{25}NO_5Na^+$ is 370.1625 and Observed = 370.1613.

3-Furan-2-yl-2-methyl-[1,2]oxazinane-4,4-dicarboxylic acid diethyl ester (3k).



3k

General procedure for the enantioselective 1,3-dipolar cycloadditions and ligand **4** was used, 4 days. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.01 (t, J = 7.0 Hz, 3H), 1.26 (t, J = 7.0 Hz, 3H), 2.30 (d, J = 14.5 Hz, 2.4 Hz, 1H), 2.37 (s, 3H), 2.51 (ddd, J = 14.0 Hz, 12.5 Hz, 5.5 Hz, 1H), 3.91 – 4.01 (m, 4H), 4.02 – 4.29 (m, 2H), 4.86 (s, 1H), 6.32 (dd, J= 3.0 Hz, 2.0 Hz, 1H), 6.40 (d, J = 3.0 Hz, 1H), 7.36 (d, J = 1.0 Hz, 1H). ^{13}C NMR ($CDCl_3$, 125 MHz) ẟ 13.9, 14.2, 25.9, 43.1, 57.2, 61.7, 62.2, 63.0, 66.9, 110.3, 111.6, 142.2, 148.8, 168.2, 169.1. $[\alpha]_D^{25}$ = +153.6 (*c* 2.0, $CHCl_3$), 79% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 18.8 min (major), t = 24.2 min (minor)). HRMS calcd. for $C_{15}H_{21}NO_6Na^+$ is 334.1261 and Observed = 334.1264.

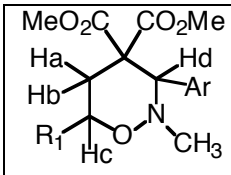
Experimental procedure for reactions with mono- and disubstituted cyclopropanes 1d-g.

The same general procedure as outlined before was used, except that shorter reaction times were required. For **3l-n**, the crude product was submitted to ^{1}H NMR for determination of cis/trans diastereomer ratios, and diastereomers were separated by FC (silica gel, hexane/ethyl acetate 95:5-80:20). The stoichiometry for these reactions were cyclopropane: nitrone: chiral catalyst = 1: 1.4: 0.3. As shown in the time table above, reactions are complete within a few hours.

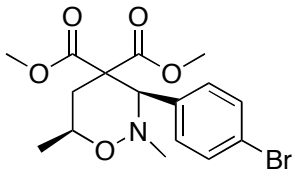
Assignment of regiochemistry and relative stereochemistry for products 3l-p. The regioselectivity of the reaction in which **3n-*cis*** and **3n-*trans*** forms is assigned because these are known compounds, which have been previously reported by Kerr and characterized by X-ray crystallography.[6] The regioselectivity in the formation of **3l-*cis***, **3l-*trans***, **3m-*cis***, and **3m-*trans*** is assigned based on analogy, and on the ^{1}H-NMR chemical shifts for the methylene hydrogens H_a and H_b. Had the nitrone oxygen instead added to the non-substituted carbon of the cyclopropane ring, the oxygen-bearing methylene group should have shown two hydrogens further downfield than is observed. The regioselectivity for **3o** and **3p** is also assigned based on the ^{1}H-NMR chemical shifts for the methylene hydrogens.

The relative cis/trans stereochemistry for **3n-*cis*** and **3n-*trans*** is assigned by comparison to the known compounds, which have been previously reported by Kerr and characterized by X-ray crystallography.[6] The relative stereochemistry for **3m-*cis***, **3m-*trans***, **3l-*cis*** and **3l-*trans*** is assigned based on ^{1}H-NMR analogy with the known compounds **3n-*cis*** and **3n-*trans***. In each case, the benzylic hydrogen H_d is further

downfield in the *cis* isomer; the hydrogen H_c on the oxygen-bearing carbon is further upfield in the *cis* isomer; and the chemical shift difference between methylene protons H_a and H_b is much smaller in the *cis* isomer. The optical rotations for the trans isomers are also negative, whereas the *cis* isomers consistently gave the normal positive rotation.

 **3m-n**	**3l-*cis***	**3l-*trans***	**3m-*cis***	**3m-*trans***	**3n-*cis***	**3n- *trans***
H_a	2.19	1.64	2.64	2.04	2.67	2.08
H_b	2.34	2.42	2.66	2.67	2.73	2.72
H_c	3.95	4.65	4.90	5.64	4.91	5.70
H_d	4.69	4.12	4.83	4.29	4.86	4.37
$[\alpha]_D^{25}$	+168.0	-61.2	+121.0	-60.9	+154.7	-49.1

***cis* 3-(4-Bromo-phenyl)-2,6-dimethyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3l cis) (Absolute stereochemistry has not been determined)**

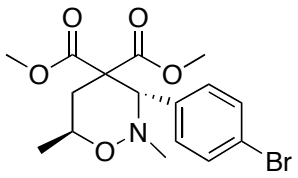


3l cis

^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.30 (d, J = 6.0 Hz, 3H), 2.19 (dd, J = 14.5 Hz, 12.0 Hz, 1H), 2.34 (dd, J = 14.5 Hz, 2.5 Hz, 1H), 2.41 (s, 3H), 3.41 (s, 3H), 3.93 (s, 3H), 3.95 (m, 1H), 4.69 (s, 1H), 7.40 – 7.44 (m, 4H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 20.4, 31.8, 43.4, 52.7, 53.5, 59.0, 67.3, 72.2, 122.7, 131.3, 132.8, 133.9, 168.6, 170.3. $[\alpha]_D^{25}$ = +168.0 (*c* 1.0, $CHCl_3$), 90% ee estimated on the basis of HPLC analysis using a chiral column

(Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 14.5 min (major), t = 21.7 min (minor)). HRMS calcd. for $C_{16}H_{20}BrNO_5Na^+$ is 408.0417 and Observed = 408.0414.

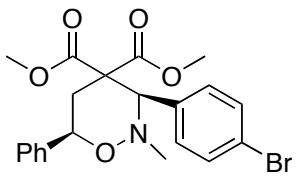
***trans* 3-(4-Bromo-phenyl)-2,6-dimethyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3l trans) (Absolute stereochemistry has not been determined)**



3l trans

^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.19 (d, J = 6.0 Hz, 3H), 1.64 (dd, J = 13.5 Hz, 10.0 Hz, 1H), 2.37 (s, 3H), 2.42 (dd, J = 14.0 Hz, 2.5 Hz, 1H), 3.46 (s, 3H), 3.65 (s, 3H), 4.12 (s, 1H), 4.65 (m, 1H), 7.23 (d, J = 8.5 Hz, 2H), 7.39 (d, J = 8.5 Hz, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 20.2, 39.3, 45.4, 52.1, 52.7, 57.9, 71.1, 72.5, 122.2, 130.9, 131.6, 136.6, 170.0, 171.1. $[\alpha]_D^{25}$ = -61.2 (*c* 1.0, $CHCl_3$), 96% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel OD-H with hexane/*i*-PrOH = 96/4 v/v, 0.5 mL/min, t = 47.5 min (major), t = 50.4 min (minor)). HRMS calcd. for $C_{16}H_{20}BrNO_5Na^+$ is 408.0417 and Observed = 408.0403.

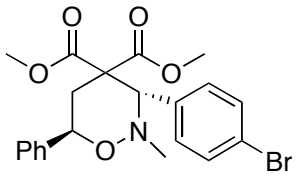
***cis* 3-(4-Bromo-phenyl)-2-methyl-6-phenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3m cis) (Absolute stereochemistry has not been determined)**



3m cis

^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.53 (s, 3H), 2.64 – 2.66 (m, 2H), 3.43 (s, 3H), 3.90 (s, 3H), 4.83 (s, 1H), 4.90 (dd, J = 8.5 Hz, 5.5 Hz, 1H), 7.34 – 7.52 (m, 9H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 31.0, 43.5, 52.8, 53.6, 59.4, 67.5, 78.1, 122.8, 126.5, 128.4, 128.8, 131.5, 132.8, 133.9, 140.0, 168.5, 170.3. $[\alpha]_D^{25}$ = +121.0 (*c* 1.0, $CHCl_3$), 90% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 25.1 min (minor), t = 33.6 min (major)). HRMS calcd. for $C_{21}H_{22}BrNO_5Na^+$ is 470.0574 and Observed = 470.0596.

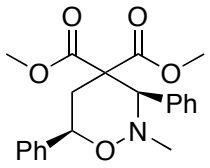
trans **3-(4-Bromo-phenyl)-2-methyl-6-phenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3m trans) (Absolute stereochemistry has not been determined)**



3m trans

^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.04 (t, J = 11.5 Hz, 1H), 2.47 (s, 3H), 2.67 (dd, J = 14.0 Hz, 2.0 Hz, 1H), 3.51 (s, 3H), 3.59 (s, 3H), 4.29 (s, 1H), 5.64 (dd, J = 10.5 Hz, 2.5 Hz, 1H), 7.29 – 7.44 (m, 9H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 39.4, 45.5, 52.1, 52.6, 57.9, 72.6, 76.9, 122.3, 126.4, 128.2, 128.7, 131.0, 131.6, 136.5, 140.4, 170.1, 170.8. $[\alpha]_D^{25}$ = -60.9 (*c* 2.0, $CHCl_3$), 95% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 19.2 min (minor), t = 31.2 min (major)). HRMS calcd. for $C_{21}H_{22}BrNO_5Na^+$ is 470.0574 and Observed = 470.0576.

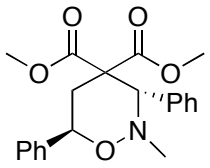
***cis* 2-Methyl-3,6-diphenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3n cis) (Absolute stereochemistry has not been determined)**



3n cis

^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.55 (s, 3H), 2.63 – 2.77 (m, 2H), 3.39 (s, 3H), 3.90 (s, 3H), 4.86(s, 1H), 4.91 (dd, J = 12.0 Hz, 3.0 Hz, 1H), 7.32-7.37 (m, 4H), 7.41-7.44 (m, 2H), 7.48 – 7.50 (m, 2H), 7.62 (br s, 2H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 31.1, 43.6, 52.6, 53.5, 59.6, 76.8, 78.1, 126.6, 128.3, 128.3, 128.4, 128.8, 131.1, 134.9, 140.3, 168.7, 170.5. $[\alpha]_D^{25}$ = +154.7 (*c* 1.0, $CHCl_3$), 90% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 20.1 min (minor), t = 33.7 min (major)). HRMS cacld. for $C_{21}H_{23}NO_5Na^+$ 392.1468 and Observed = 392.1452.

***trans* 2-Methyl-3,6-diphenyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3n trans) (Absolute stereochemistry has not been determined)**

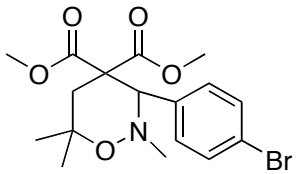


3n trans

^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.08 (t, J = 11.5 Hz, 1H), 2.52 (s, 3H), 2.72 (dd, J = 13.5 Hz, 2.0 Hz, 1H), 3.48 (s, 3H), 3.58 (s, 3H), 4.37(s, 1H), 5.70 (dd, J = 10.0 Hz, 2.5 Hz, 1H), 7.28-7.33 (m, 4H), 7.36-7.39 (m, 2H), 7.43 – 7.44 (m, 4H). ^{13}C NMR ($CDCl_3$, 125 MHz) δ 39.3, 45.4, 51.9, 52.4, 58.0, 73.0, 76.8, 126.3, 127.7, 128.0, 128.2, 128.5, 129.8, 137.4, 140.6, 170.2, 170.8. $[\alpha]_D^{25}$ = -49.1 (*c* 2.0, $CHCl_3$), 96% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3

v/v, 0.5 mL/min, t = 19.5 min (minor), t = 29.7 min (major)). HRMS cacld. for $C_{21}H_{23}NO_5Na^+$ 392.1468 and Observed = 392.1464.

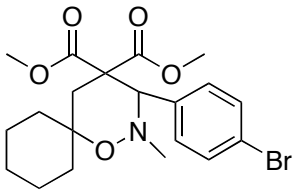
3-(4-Bromo-phenyl)-2,6,6-trimethyl-[1,2]oxazinane-4,4-dicarboxylic acid dimethyl ester (3o)



3o

^{1}H NMR ($CDCl_3$, 500 MHz, 50 °C) δ 1.17 (s, 3H), 1.39 (s, 3H), 2.28 (d, J = 14.5 Hz, 1H), 2.40 (s, 3H), 2.51 (d, J = 14.5 Hz, 1H), 3.27 (s, 3H), 3.79 (s, 3H), 4.70 (s, 1H), 7.34 (d, J = 8.0 Hz, 2H), 7.41 (d, J = 8.5 Hz, 2H). ^{13}C NMR (C_6D_6, 125 MHz, 60 °C) δ 19.9, 25.4, 29.6, 36.9, 43.9, 52.1, 52.6, 59.1, 75.0, 122.9, 131.7, 132.7, 133.1, 169.3, 171.5. $[\alpha]_D^{25}$ = +164.5 (*c* 1.0, $CHCl_3$), 96% ee estimated on the basis of HPLC analysis using a chiral column (Diacel Chiralcel AD with hexane/*i*-PrOH = 97/3 v/v, 0.5 mL/min, t = 13.3 min (major), t = 15.8 min (minor)). HRMS calcd. for $C_{17}H_{22}BrNO_5Na^+$ is 422.0574. Observed = 422.0559.

3-(4-Bromo-phenyl)-2-methyl-1-oxa-2-aza-spiro[5.5]undecane-4,4-dicarboxylic acid dimethyl ester (3p).



3p

^{1}H NMR ($CDCl_3$, 500 MHz, 50 °C) δ 1.19-1.72 (m, 10H), 2.32 (d, J = 14.5 Hz, 1H), 2.37 (d, J = 14.5 Hz, 1H), 2.41 (s, 3H), 3.27 (s, 3H), 3.77 (s, 3H), 4.70 (s, 1H), 7.32-7.43 (m, 4H). ^{13}C NMR (C_6D_6, 125 MHz, 60 °C) δ 22.7, 26.5, 32.4, 35.1, 36.2, 38.9, 44.4, 52.3, 52.7, 57.6, 67.1, 75.6, 122.9, 131.6, 133.6, 134.1, 169.3, 171.6. $[\alpha]_D^{25}$ = -32.2 (*c* 1.0, $CHCl_3$), 99% ee estimated on the basis of HPLC analysis using a chiral column (Diacel

Chiralcel AD-H with hexane/*i*-PrOH = 99/1 v/v, 0.8 mL/min, t = 79.8 min (major), t = 86.0 min (minor)). HRMS cacld. for $C_{20}H_{26}BrNO_5Na^+$ is 462.0887 and observed = 462.0876.

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