SUPPORTING INFORMATION

for
the
communication
entitled

Highly Substituted 2-Amido-Furans From Rh(II)-Catalyzed Cyclopropenations of Ynamides.

authored by

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GENERAL EXPERIMENTAL INFORMATION

All reactions were performed in flame-dried glassware under nitrogen atmosphere. Solvents were distilled prior to use. Reagents were used as purchased from Aldrich, Acros, Alfa Aesar, or TCI unless otherwise noted. Chromatographic separations were performed using Silicycle 43-60 Å SiO_2. ^1H and ^{13}C NMR spectra were obtained on Varian VI-400 and VI-500 spectrometers using $CDCl_3$ with TMS or residual solvent as standard unless otherwise noted. Melting points were determined using a Laboratory Devices MEL-TEMP and are uncorrected/calibrated. Infrared spectra were obtained on Bruker EQUINOX 55 FTIR. TLC analysis was performed using Aldrich 254 nm polyester-backed plates (60 Å, 250 μm) and visualized using UV and $KMnO_4$ stains. Low-resolution mass spectra were obtained using an Agilent 1100 series LS/MSD and APCI unless otherwise noted. X-Ray analysis performed at University of Minnesota Department of Chemistry X-Ray facility. All spectral data obtained for new compounds are reported here.

GENERAL PROCEDURE FOR PREPARATIONS OF YNAMIDES.[1,2]

Copper catalyzed coupling of amides and 1-bromo-2-triisopropylsilylacetylene: To a mixture of amide (1.0 equiv), K_3PO_3 (2.0 equiv), $CuSO_4 \bullet 5H_2O$ (0.15 equiv), and 1,10-phenanthroline (0.3 equiv) in a reaction flask was added 1-bromo-2-triisopropylsilylacetylene (1.0-1.2 equiv) and toluene (5 mL for every 2.0 mmol of the amide). The reaction mixture was placed under a blanket of nitrogen and heated in an oil bath at 80 °C for 48 h while being monitored with TLC analysis. Upon completion, the reaction mixture was cooled to rt, diluted with EtOAc, and filtered through Celite™. The filtrate was concentrated *in vacuo*. The crude products were purified by silica gel flash column chromatography [gradient eluent: EtOAc in hexane] to afford the respective TIPS protected ynamides.

Deprotection of TIPS-acetylene: To a solution of TIPS protected ynamide (1.0 equiv) in anhydrous THF (5 mL for every 2 mmol of ynamide) stirring at 0 °C was added TBAF (1.0 *M* solution in THF, 1.5 equiv) via syringe over a period of 5 min. The resulting solution was stirred at 0 °C. After TLC indicated that the starting material was completely consumed, the solution was concentrated *in vacuo*, and purification of the crude residue via silica gel flash column chromatography [eluent: EtOAc/hexane] afforded the respective terminally unsubstituted ynamides.

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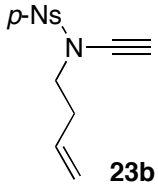
1. Zhang. X.; Zhang, Y.; Huang, J.; Hsung, R. P.; Kurtz, K. C. M.; Oppenheimer, J.; Petersen, M. E.; Sagamanova, I. K.; Shen, L.; Tracey, M. R. *J. Org. Chem.* **2006**, *71*, 4170.

2. Zhang, Y.; Hsung, R. P.; Tracey, M. R.; Kurtz, K. C. M.; Vera, E. L. *Org. Lett.* **2004**, *6*, 1151.

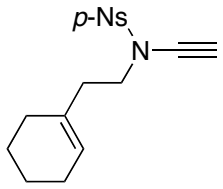
CHARACTERIZATIONS OF NEW YNAMIDES.



23b

Ynamide **23b** (673 mg, 2.4 mmol) was prepared in 72% yield (two steps) according to the general procedure.

23b: R_f = 0.33 [50% CH_2Cl_2 in hexanes]; mp 77.0-78.5 °C;
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.42 (dt, 2 H, *J* = 7.0, 7.5 Hz), 2.80 (s, 1 H), 3.45 (t, 2 H, *J* = 7.5 Hz), 5.05-5.13 (m, 2 H), 5.69 (ddt, 1 H, *J* = 7.0, 10.5, 17.0 Hz), 8.10-8.13 (m, 2 H), 8.40-8.43 (m, 2 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 32.3, 51.3, 60.6, 74.9, 118.7, 124.7, 129.2, 133.2, 143.2, 151.0;
IR (film) cm^{-1} 3284(m), 3117(w), 2139(m), 1722(w), 1642(w), 1608(w), 1526(s), 1459(w), 1402(w), 1369(s);
mass spectrum (APCI): m/e (% relative intensity) 281.1 (100) $(M + H)^+$.

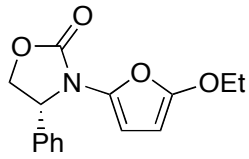


24

Ynamide **24** (1.4 g, 41.9 mmol) was prepared in 83% yield (two steps) according to the general procedure.

24: R_f = 0.32 [67% CH_2Cl_2 in hexanes]; mp 124.0-125.5 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 1.50-1.56 (m, 2 H), 1.58-1.64 (m, 2 H), 1.89-1.98 (m, 4 H), 2.27 (t, 2 H, *J* = 7.6 Hz), 2.79 (s, 1 H), 3.45 (t, 2 H, *J* = 7.6 Hz), 5.44-5.45 (m, 1 H), 8.10-8.13 (m, 2 H), 8.39-8.43 (m, 2 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 22.4, 23.0, 25.5, 28.3, 36.4, 50.7, 60.3, 75.2, 124.7, 125.0, 129.1, 133.0, 143.3, 150.9;
IR (film) cm^{-1} 3305(m), 3118(w), 2925(m), 2832(m), 2139(m), 1945(w), 1811(w), 1695(w), 1606(m), 1538(s), 1439(w), 1402(m), 1374(s), 1352(s);
mass spectrum (APCI): m/e (% relative intensity) 335.1 (100) $(M + H)^+$.

CHARACTERIZATIONS OF 8, 9 AND 10.



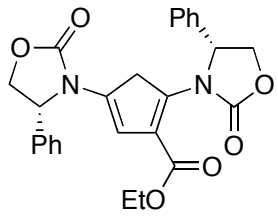
8

8: R_f = 0.28 [33% EtOAc in hexanes];

^{1}H NMR (500 MHz, $CDCl_3$) δ 1.32 (t, 3 H, J = 7.5 Hz), 3.94-4.00 (m, 2 H), 4.27 (dd, 1 H, J = 7.0, 9.0 Hz), 4.76 (dd, 1 H, J = 9.0, 9.0 Hz), 5.01 (d, 1 H, J = 3.0 Hz), 5.15 (dd, 1 H, J = 7.0, 9.0 Hz), 5.92 (d, 1 H, J = 3.0 Hz), 7.31 -7.40 (m, 5 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 14.7, 62.0, 67.1, 70.6, 82.3, 106.4, 127.2, 129.35, 129.40, 133.0, 138.0, 156.4, 157.8;

mass spectrum (APCI): m/e (% relative intensity) 274.1 (100) $(M + H)^+$.

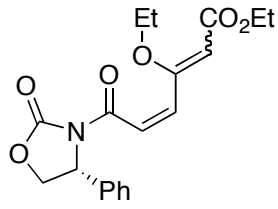


9

9: R_f = 0.12 [33% EtOAc in hexanes];

^{1}H NMR (500 MHz, $CDCl_3$) δ 1.26 (t, 3 H, J = 7.0 Hz), 3.64 (d, 1 H, J = 24.5 Hz), 3.90 (d, 1 H, J = 24.5 Hz), 4.11-4.19 (m, 4 H), 4.72-4.77 (m, 2 H), 5.18 (dd, 1 H, J = 5.0, 9.0 Hz), 5.76 (s, 1 H), 5.99 (dd, 1 H, J = 6.0, 9.0 Hz), 6.89-6.91 (m, 2 H), 7.10-7.13 (m, 2 H), 7.17-7.22 (m, 3 H), 7.38-7.42 (m, 3 H);

mass spectrum (APCI): m/e (% relative intensity) 461.2 (100) $(M + H)^+$.



10

10: R_f = 0.22 [25% EtOAc in hexanes];

^{1}H NMR (500 MHz, $CDCl_3$) δ 1.19 (t, 3 H, J = 7.0 Hz), 1.28 (t, 3 H, J = 7.0 Hz), 4.05 (q, 2 H, J = 7.0 Hz), 4.11-4.18 (m, 3 H), 4.71 (dd, 1 H, J = 8.5, 8.5 Hz), 5.12 (dd, 1 H, J = 8.5, 8.5 Hz), 5.67 (d, 1 H, J = 1.5 Hz), 6.03 (d, 1 H, J = 12.0 Hz), 6.90 (dd, 1 H, J = 1.5, 12.0 Hz), 7.27-7.29 (m, 2 H), 7.37-7.40 (m, 1 H), 7.42 -7.45 (m, 2 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 14.39, 14.44, 60.4, 61.0, 61.8, 71.0, 107.0, 122.8, 126.2, 129.3, 129.9, 138.5, 138.9, 146.8, 154.9, 165.3, 166.3;
mass spectrum (APCI): m/e (% relative intensity) 360.1 (51) $(M + H)^+$, 314.1 (100).

GENERAL PROCEDURE OF THE FURAN SYNTHESIS USING IODONIUM YLIDE.

To a solution of ynamide **7** [28.0 mg, 0.15 mmol] in CH_2Cl_2 [1 mL] were added $Rh_2(OAc)_4$ catalyst [3.30 mg, 0.0075 mmol, 5 mol %] and 4Å MS [28 mg]. The resulting mixture was stirred at rt while iodonium ylide [101.0 mg, 0.30 mmol, 2.0 equiv] was added in four portions over 1-1.5 h. After the addition of the last portion of iodonium ylide, the reaction mixture was stirred for an additional 0.5 h. When the reaction was complete, the mixture was filtered through a pad of Celite™ and concentrated *in vacuo*. The crude residue was purified by silica gel flash column chromatography.

GENERAL PROCEDURE OF THE FURAN SYNTHESIS USING DIAZO COMPOUNDS.

To a solution of ynamide **7** [37.0 mg, 0.20 mmol] in toluene [1.4 mL] was added $Rh_2(OAc)_4$ [1.80 mg, 0.0040 mmol, 2 mol %]. The mixture was heated to 80 °C at which time a solution of dimethyl diazomalonate [100.0 mg, 0.60 mmol, 3.0 equiv] in toluene [2 mL] was added via a syringe pump over 1-2 h. The reaction progress was monitored by TLC analysis. When the reaction was complete, the mixture was filtered through a pad of Celite™ and concentrated *in vacuo*. The crude residue was purified by silica gel flash column chromatography.

SPECIAL NOTES:

Furan Synthesis Using Iodonium Ylide.

For ynamide **29a**: 2 equiv of ylide was added to a solution of 1 equiv ynamide and 0.05 equiv $Rh_2(OAc)_4$ in CH_2ClCH_2Cl (0.15 *M*) at 50 °C. The resulting mixture was stirred for 24 h.

For ynamide **29b**: 2 equiv of ylide was added to a solution of 1 equiv ynamide and 0.05 equiv $Rh_2(OAc)_4$ in CH_2ClCH_2Cl (0.15 *M*) at 50 °C. After stirring for 24 h, another 2 equiv of ylide was added and the solution was stirred at 50 °C for an additional 24 h.

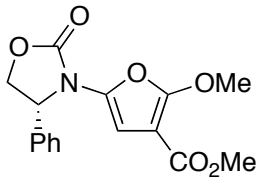
For synthesis of 2-Amido-Furan **31**: 3 equiv of ylide was added in several portions in 8 hours to a solution of 1 equiv ynamide and 0.05 equiv $Rh_2(OAc)_4$ in toluene (0.15 *M*) at rt without 4Å MS. The resulting mixture was stirred for 20 h.

Furan Synthesis Using Diazo Compounds.

For ynamides **29a** and **29b:**

To a solution of ynamide **29a [**58.0 mg**,** 0.20 mmol] in toluene [1.4 mL] was added $Rh_2(OAc)_4$ [4.40 mg, 0.010 mmol, 5 mol %]. The mixture was heated to refluxing at which time a solution of dimethyl diazomalonate [130.0 mg, 0.80 mmol, 4.0 equiv] in toluene [2.7 mL] was added via a syringe pump over 1.5 h. The reaction mixture was stirred for an addition 0.5 h at refluxing, and the reaction progress was monitored by TLC analysis. When the reaction was complete, the mixture was filtered through a pad of Celite™ and concentrated *in vacuo*. The crude residue was purified by silica gel flash column chromatography.

CHARACTERIZATIONS OF 2-AMIDO-FURANS.

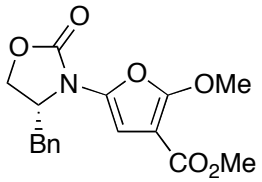


14

Using Iodonium Ylide: 2-Amido-Furan **14** (23.0 mg, 0.072 mmol) was isolated in 48% yield from ynamide **7** (28.0 mg, 0.15 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **14** (44.7 mg, 0.14 mmol) was isolated in 70% yield from ynamide **7** (37.0 mg, 0.20 mmol) according to the general procedure.

14: R_f = 0.11 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 122.1 (*c* 2.7, $CHCl_3$);
^{1}H NMR (500 MHz, $CDCl_3$) δ 3.73 (s, 3 H), 3.93 (s, 3 H), 4.33 (dd, 1 H, *J* = 7.0, 9.0 Hz), 4.80 (dd, 1 H, *J* = 9.0, 9.0 Hz), 5.11 (dd, 1 H, *J* = 7.0, 9.0 Hz), 6.31 (s, 1 H), 7.32-7.34 (m, 2 H), 7.38-7.43 (m, 3 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 51.5, 58.4, 62.3, 70.7, 92.7, 107.2, 127.3, 129.6, 129.7, 133.1, 137.4, 156.0, 159.3, 163.0;
IR (film) cm^{-1} 2955(w), 1764(s), 1708(s), 1601(s), 1475(m) , 1457(m), 1437(m), 1395(m);
mass spectrum (APCI): m/e (% relative intensity) 318.1 (100) $(M + H)^+$.

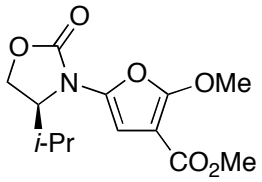


18

Using Iodonium Ylide: 2-Amido-Furan **18** (31.5 mg, 0.095 mmol) was isolated in 44% yield from ynamide **15** (43.3 mg, 0.22 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **18** (35.4 mg, 0.107 mmol) was isolated in 82% yield from ynamide **15** (26.2 mg, 0.13 mmol) according to the general procedure.

18: R_f = 0.12 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 31.3 (*c* 1.6, $CHCl_3$);
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.83 (dd, 1 H, *J* = 8.5, 13.5 Hz), 3.10 (dd, 1 H, *J* = 4.0, 13.5 Hz), 3.80 (s, 3 H), 4.08 (s, 3 H), 4.17-4.19 (m, 1 H), 4.35-4.40 (m, 2 H), 6.54 (s, 1 H), 7.13-7.15 (m, 2 H), 7.24-7.28 (m, 1 H), 7.30-7.33 (m, 2 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 39.3, 51.6, 58.7, 58.8, 67.8, 93.0, 107.5, 127.6, 129.2 129.3, 133.1, 135.0, 156.0, 159.6, 163.0;
IR (film) cm^{-1} 2955(w), 1764(s), 1707(s), 1602(s), 1476(m) , 1455(m), 1437(m), 1403(m);
mass spectrum (APCI): m/e (% relative intensity) 332.1 (100) $(M + H)^+$.



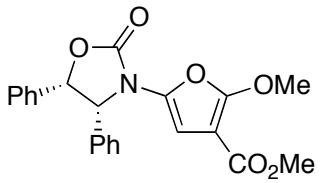
19

Using Iodonium Ylide: 2-Amido-Furan **19** (28.3 mg, 0.10 mmol) was isolated in 48% yield from ynamide **16** (31.9 mg, 0.21 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **19** (35.1 mg, 0.124 mmol) was isolated in 65% yield from ynamide **16** (29.6 mg, 0.19 mmol) according to the general procedure.

19: R_f = 0.09 [20% EtOAc in hexanes]; $[\alpha]_D^{20}$ = + 44.8 (*c* 1.485, $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 0.92 (d, 3 H, *J* = 6.8 Hz), 0.96 (d, 3 H, *J* = 6.8 Hz), 2.01 (dsept, 1 H, *J* = 3.6, 6.8 Hz), 3.79 (s, 3 H), 4.07 (ddd, 1 H, *J* = 3.6, 5.6, 8.8 Hz), 4.09 (s, 3 H), 4.22 (dd, 1 H, *J* = 5.6, 8.8 Hz), 4.45 ((dd, 1 H, *J* = 5.6, 8.8 Hz), 6.50 (s, 1 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 15.0, 17.7, 29.4, 51.6, 58.7, 62.1, 64.3, 93.0, 107.5, 133.3, 156.5, 159.5, 163.1;
IR (film) cm^{-1} 2959(w), 1761(s), 1717(s), 1602(s), 1476(m) , 1437(m), 1405(m);

mass spectrum (APCI): m/e (% relative intensity) 284.1 (100) $(M + H)^+$.

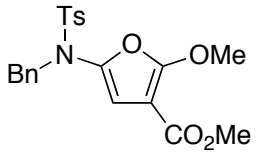


20

Using Iodonium Ylide: 2-Amido-Furan **20** (38.0 mg, 0.097 mmol) was isolated in 48% yield from ynamide **17** (53.7 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **20** (60.7 mg, 0.154 mmol) was isolated in 77% yield from ynamide **17** (52.6 mg, 0.20 mmol) according to the general procedure.

20: R_f = 0.19 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = -70.1 (*c* 3.095, $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 3.73 (s, 3 H), 3.96 (s, 3 H), 5.39 (d, 1 H, *J* = 8.0 Hz), 6.05 (d, 1 H, *J* = 8.0 Hz), 6.39 (s, 1 H), 6.92-6.94 (m, 2 H), 6.99-7.02 (m, 2 H), 7.09-7.13 (m, 6 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 51.6, 58.6, 67.2, 80.7, 92.8, 106.3, 126.3, 127.9, 128.3, 128.57, 128.59, 129.0, 133.5, 133.87, 133.92, 156.0, 159.2, 163.0, ;
IR (film) cm^{-1} 3006(w), 1764(s), 1712(s), 1602(s), 1455(m), 1436(m), 1369(m);
mass spectrum (APCI): m/e (% relative intensity) 394.1 (75) $(M + H)^+$, 350 (100).

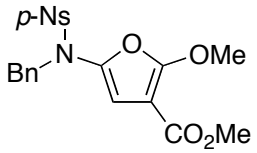


25

Using Iodonium Ylide: 2-Amido-Furan **25** (20.0 mg, 0.048 mmol) was isolated in 24% yield from ynamide **21** (57.1 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **25** (42.0 mg, 0.101 mmol) was isolated in 50% yield from ynamide **21** (59.0 mg, 0.21 mmol) according to the general procedure.

25: R_f = 0.09 [20% EtOAc in hexanes]; mp 127.5-128.5 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 2.45 (s, 3 H), 3.72 (s, 3 H), 3.85 (s, 3 H), 4.59 (s, 2 H), 6.20 (s, 1 H), 7.19-7.22 (m, 2 H), 7.25-7.27 (m, 3 H), 7.31-7.34 (m, 2 H), 7.67-7.69 (m, 2 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 21.8, 51.5, 54.8, 58.1, 92.3, 110.6, 127.9, 128.3, 128.7, 128.9, 130.0, 135.3, 135.5, 136.0, 144.5, 159.6, 163.0;
IR (film) cm^{-1} 2983(m), 2889(w), 1715(s), 1595(s), 1456(m), 1399(m), 1375(m), 1351(s);
mass spectrum (APCI): m/e (% relative intensity) 416.1 (100) $(M + H)^+$.



26

Using Iodonium Ylide: 2-Amido-Furan **26** (26.2 mg, 0.059 mmol) was isolated in 29% yield from ynamide **22** (64.3 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **26** (41.8 mg, 0.094 mmol) was isolated in 47% yield from ynamide **22** (63.3 mg, 0.20 mmol) according to the general procedure.

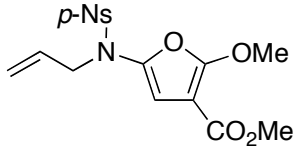
26: R_f = 0.17 [25% EtOAc in hexanes]; mp 123.5-125.5 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 3.74 (s, 3 H), 3.89 (s, 3 H), 4.66 (s, 2 H), 6.24 (s, 1 H), 7.20-7.22 (m, 2 H), 7.28-7.30 (m, 3 H), 7.93-7.96 (m, 2 H), 8.34-8.36 (m, 2 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 51.7, 55.6, 58.4, 92.8, 111.3, 124.6, 128.8, 129.0, 129.03, 129.2, 134.60, 124.61, 144.9, 150.6, 159.9, 162.8;

IR (film) cm^{-1} 2983(w), 1739(m), 1715(s), 1594(s), 1532(s), 1500(w), 1455(m), 1438(m), 1402(m), 1353(s);

mass spectrum (APCI): m/e (% relative intensity) 447.1 (70) $(M + H)^+$, 261.1 (100).



27a

Using Iodonium Ylide: 2-Amido-Furan **27a** (25.6 mg, 0.065 mmol) was isolated in 32% yield from ynamide **23a** (53.3 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **27a** (37.1 mg, 0.094 mmol) was isolated in 49% yield from ynamide **23a** (51.5 mg, 0.19 mmol) according to the general procedure.

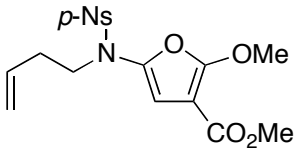
27a: R_f = 0.3 [30% EtOAc in hexanes]; mp 129.5-132.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 3.78 (s, 3 H), 3.99 (s, 3 H), 4.12 (d, 2 H, J = 6.4 Hz), 5.17-5.21 (m, 2 H), 5.73 (ddt, 1 H, J = 6.4, 10.0, 16.8 Hz), 6.36 (s, 1 H), 7.98-8.02 (m, 2 H), 8.37-8.40 (m, 2 H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 51.6, 58.2, 58.4, 92.7, 111.1, 120.6, 124.6, 129.2, 131.4, 134.5, 144.8, 150.7, 159.9, 162.8;

IR (film) cm^{-1} 3108(w), 3006(m), 2990(m), 1737(s), 1714(s), 1592(s), 1528(s), 1454(m), 1401(m);

mass spectrum (APCI): m/e (% relative intensity) 429.0 (100), 397.0 (62) $(M + H)^+$.

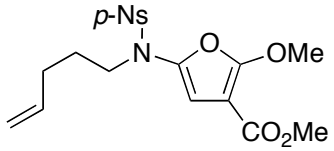


27b

Using Iodonium Ylide: 2-Amido-Furan **27b** (28.8 mg, 0.070 mmol) was isolated in 35% yield from ynamide **23b** (56.7 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **27b** (35.5 mg, 0.087 mmol) was isolated in 58% yield from ynamide **23b** (42.6 mg, 0.15 mmol) according to the general procedure.

27b: R_f = 0.13 [20% EtOAc in hexanes]; mp 129.5-131.5 °C;
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.29 (dt, 2 H, J = 7.0, 14.0 Hz), 3.55 (t, 2 H, J = 7.0 Hz), 3.79 (s, 3 H), 4.00 (s, 3 H), 5.05-5.09 (m, 2 H), 5.68 (ddt, 1 H, J = 7.0, 10.0, 18.0 Hz), 6.39 (s, 1 H), 7.98-8.00 (m, 2 H), 8.37-8.40 (m, 2 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 33.1, 50.7, 51.7, 58.5, 92.9, 111.3, 118.2, 124.6, 129.2, 133.7, 134.4, 144.7, 150.7, 160.0, 162.8;
IR (film) cm^{-1} 3115(w), 2971(m), 1737(m), 1717(s), 1590(s), 1528(s), 1454(m), 1401(m);
mass spectrum (APCI): m/e (% relative intensity) 411.1 (100) $(M + H)^+$.

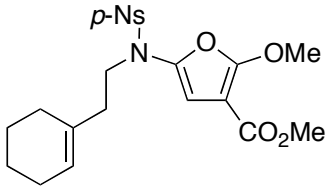


27c

Using Iodonium Ylide: 2-Amido-Furan **27c** (38.6 mg, 0.091 mmol) was isolated in 47% yield from ynamide **23c** (57.2 mg, 0.194 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **27c** (38.6 mg, 0.091 mmol) was isolated in 61% yield from ynamide **23c** (43.6 mg, 0.148 mmol) according to the general procedure.

27c: R_f = 0.26 [25% EtOAc in hexanes]; mp 92.5-95.0 °C;
^{1}H NMR (500 MHz, $CDCl_3$) δ 1.63 (tt, 2 H, J = 7.5, 7.5 Hz), 2.09 (dt, 2 H, J = 7.0, 7.5 Hz), 3.48 (t, 2 H, J = 7.5 Hz), 3.79 (s, 3 H), 3.99 (s, 3 H), 4.99-5.03 (m, 2 H), 5.74 (ddt, 1 H, J = 6.5, 10.5, 17.0 Hz), 6.39 (s, 1 H), 7.97-8.00 (m 2 H), 8.37-8.40 (m, 2 H);
^{13}C NMR (125 MHz, $CDCl_3$) δ 27.8, 30.4, 50.8, 51.7, 58.5, 92.9, 111.0, 116.1, 124.6, 129.1, 134.6, 137.0, 144.7, 150.7, 159.9, 162.8;
IR (film) cm^{-1} 2981(m), 1737(s), 1643(w), 1603(m), 1528(m), 1437(m), 1350(s);
mass spectrum (APCI): m/e (% relative intensity) 425.1 (100) $(M + H)^+$.

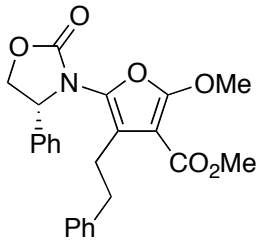


28

Using Iodonium Ylide: 2-Amido-Furan **28** (36.2 mg, 0.078 mmol) was isolated in 39% yield from ynamide **24** (66.3 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **28** (73.1 mg, 0.157 mmol) was isolated in 52% yield from ynamide **24** (100.6 mg, 0.30 mmol) according to the general procedure.

28: R_f = 0.27 [20% EtOAc in hexanes]; mp 112.0-114.0 °C;
IR (film) cm^{-1} 2982(s), 2362(w), 1719(s), 1592(m), 1528(m), 1455(m), 1353(s);
^{1}H NMR (400 MHz, $CDCl_3$) δ 1.50-1.62 (m, 4 H), 1.87 (m, 2 H), 1.95-1.96 (m, 2 H), 2.15 (t, 2 H, J = 7.6 Hz), 3.55 (t, 2 H, J = 7.6 Hz), 3.79 (s, 3 H), 3.99 (s, 3 H), 5.40 (m, 1 H), 6.36 (s, 1 H), 7.97-8.00 (m, 2 H), 8.36-8.40 (m, 2 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 22.3, 22.9, 25.4, 28.3, 37.2, 49.8, 51.6, 58.4, 92.8, 111.0, 124.53, 124.55, 129.1, 133.3, 134.6, 144.8, 150.6, 159.8, 162.8;
mass spectrum (APCI): m/e (% relative intensity) 465.1 (100) $(M + H)^+$.



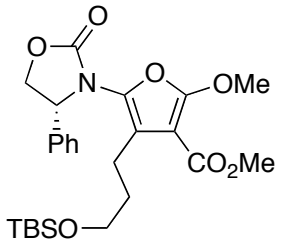
30a

Using Iodonium Ylide: 2-Amido-Furan **30a** (46.6 mg, 0.111 mmol) was isolated in 37% yield from ynamide **29a** (87.4 mg, 0.30 mmol) according to the procedure noted in the **SPECIAL NOTES**.

Using Diazo Compounds: 2-Amido-Furan **30a** (38.3 mg, 0.091 mmol) was isolated in 45% yield from ynamide **29a** (58.3 mg, 0.20 mmol) according to the procedure noted in the **SPECIAL NOTES**.

30a: R_f = 0.17 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 114.3 (*c* 1.815, $CHCl_3$);
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.60-2.71 (m, 2 H), 2.77-2.88 (m, 2 H), 3.76 (s, 3 H), 3.78 (s, 3 H), 4.24 (dd, 1 H, J = 6.5, 9.0 Hz), 4.30 (dd, 1 H, J = 6.5, 9.0 Hz), 4.64 (dd, 1 H, J = 9.0, 9.0 Hz), 7.20-7.24 (m, 5 H), 7.31-7.35 (m, 5 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 26.8, 35.6, 51.3, 57.6, 62.2, 70.4, 91.4, 122.8, 126.2, 127.6, 128.6, 129.0, 129.2, 129.5, 129.9, 137.9, 142.5, 156.2, 160.3, 163.5;

IR (film) cm^{-1} 2971(m), 2918(m), 2850(w), 1761(s), 1703(s), 1594(s), 1455(m), 1392(s), 1370(s); mass spectrum (APCI): m/e (% relative intensity) 422.1 (100) $(M + H)^+$.

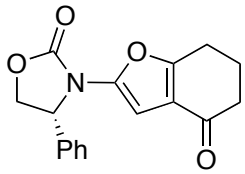


30b

Using Iodonium Ylide: 2-Amido-Furan **30b** (32.7 mg, 0.067 mmol) was isolated in 22% yield from ynamide **29b** (109.3 mg, 0.304 mmol) according to the procedure noted in the **SPECIAL NOTES**.

Using Diazo Compounds: 2-Amido-Furan **30b** (17.8 mg, 0.036 mmol) was isolated in 24% yield from ynamide **29b** (54.0 mg, 0.15 mmol) according to the procedure noted in the **SPECIAL NOTES**.

30b: R_f = 0.25 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 90.5 (*c* 2.26, $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 0.00 (s, 6 H), 0.85 (s, 9 H), 1.38-1.48 (m, 1 H), 1.52-1.61 (m, 1 H), 2.39 (t, 2 H, *J* = 8.0 Hz), 3.49-3.55 (m, 2 H), 3.64 (s, 3 H), 3.78 (s, 3 H), 4.30 (dd, 1 H, *J* = 7.2, 8.8 Hz), 4.70 (dd, 1 H, *J* = 8.8, 8.8 Hz), 5.01 (dd, 1 H, *J* = 7.2, 8.8 Hz), 7.29 (s, 5 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, 18.6, 20.9, 26.2, 32.7, 51.1, 57.7, 62.5, 62.9, 70.4, 91.7, 123.9, 127.7, 129.3, 129.5, 129.6, 137.3, 156.4, 160.4, 163.4;
IR (film) cm^{-1} 2954(m), 2857(w), 1772(s), 1709(s), 1595(s), 1472(m), 1460(m), 1436(m), 1373(s); mass spectrum (APCI): m/e (% relative intensity) 490.2 (100) $(M + H)^+$.



31

Using Iodonium Ylide: 2-Amido-Furan **31** (50.0 mg, 0.168 mmol) was isolated in 56% yield from ynamide **7** (56.2 mg, 0.30 mmol) according to the procedure noted in the **SPECIAL NOTES**.

Using Diazo Compounds: 2-Amido-Furan **31** (20.2 mg, 0.068 mmol) was isolated in 69% yield from ynamide **7** (18.4 mg, 0.098 mmol) according to the general procedure.

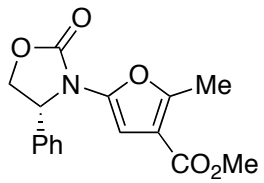
31: R_f = 0.11 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 131.5 (*c* 1.755, $CHCl_3$);
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.10 (tt, 2 H, *J* = 6.5, 6.5 Hz), 2.41 (m, 2 H), 2.75 (m, 2 H), 4.30 (dd, 1 H, *J* = 6.5, 9.0 Hz), 4.81 (dd, 1 H, *J* = 9.0, 9.0 Hz), 5.24 (dd, 1 H, *J* = 6.5, 9.0 Hz), 6.29 (s, 1 H), 7.32-7.34

(m, 2 H), 7.36-7.41 (m, 3 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 22.5, 23.3, 37.6, 61.6, 71.0, 98.9, 122.4, 127.0, 129.63, 129.64, 137.5, 143.9, 155.4, 163.9, 194.0;

IR (film) cm^{-1} 2971(w), 1763(s), 1672(s), 1618(m), 1594(m), 1494(w), 1456(m), 1395(s), 1363(m);

mass spectrum (APCI): m/e (% relative intensity) 298.1 (100) $(M + H)^+$.



32

Using Iodonium Ylide: 2-Amido-Furan **32** (49.1 mg, 0.163 mmol) was isolated in 55% yield from ynamide **7** (56.2 mg, 0.20 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **32** (19.8 mg, 0.065 mmol) was isolated in 57% yield from ynamide **7** (21.0 mg, 0.112 mmol) according to the general procedure.

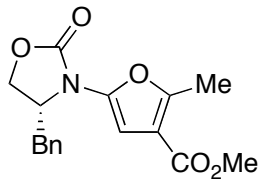
32: R_f = 0.27 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 139.7 (*c* 0.885, $CHCl_3$);

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.43 (s, 3 H), 3.75 (s, 3 H), 4.30 (dd, 1 H, *J* = 6.4, 8.8 Hz), 4.81 (dd, 1 H, *J* = 8.8, 8.8 Hz), 5.25 (dd, 1 H, *J* = 6.4, 8.8 Hz), 6.33 (s, 1 H), 7.31-7.33 (m, 2 H), 7.35-7.39 (m, 3 H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 13.7, 51.5, 61.2, 70.8, 102.4, 114.6, 126.9, 129.4, 129.5, 137.6, 141.4, 155.3, 155.9, 164.0;

IR (film) cm^{-1} 2982(m), 1764(s), 1714(s), 1627(m), 1593(s), 1440(m), 1400(s), 1366(m);

mass spectrum (APCI): m/e (% relative intensity) 302.1 (100) $(M + H)^+$.



33

Using Iodonium Ylide: 2-Amido-Furan **33** (45.7 mg, 0.145 mmol) was isolated in 48% yield from ynamide **15** (60.4 mg, 0.30 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **33** (38.9 mg, 0.123 mmol) was isolated in 61% yield from ynamide **15** (40.7 mg, 0.202 mmol) according to the general procedure.

33: R_f = 0.28 [33% EtOAc in hexanes]; $[\alpha]_D^{20}$ = - 26.5 (*c* 1.92, $CHCl_3$);

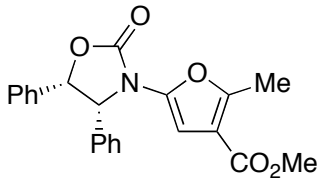
^{1}H NMR (500 MHz, $CDCl_3$) δ 2.54 (s, 3 H), 2.85 (dd, 1 H, *J* = 8.5, 14.0 Hz), 3.11 (dd, 1 H, *J* = 4.5, 14.0

Hz), 3.82 (s 3 H), 4.19 (dd, 1 H, J = 5.0, 9.0 Hz), 4.37 (dd, 1 H, J = 8.5, 8.5 Hz), 4.47-4.52 (m, 1 H), 6.53 (s, 1 H), 7.13-7.14 (m, 2 H), 7.24-7.32 (m, 3 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 13.8, 39.3, 51.7, 58.0, 67.5, 102.0, 114.9, 127.6, 129.2, 129.4, 135.1, 141.7, 155.0, 155.7, 164.2;

IR (film) cm^{-1} 2982(m), 1762(s), 1716(s), 1626(w), 1599(m), 1440(m), 1406(m), 1378(m);

mass spectrum (APCI): m/e (% relative intensity) 316.1 (100) $(M + H)^+$.



34

Using Iodonium Ylide: 2-Amido-Furan **34** (53.7 mg, 0.142 mmol) was isolated in 47% yield from ynamide **17** (80.2 mg, 0.305 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **34** (43.6 mg, 0.116 mmol) was isolated in 63% yield from ynamide **17** (48.2 mg, 0.183 mmol) according to the general procedure.

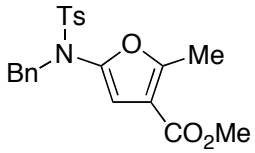
34: R_f = 0.5 [33% EtOAc in hexanes]; mp 98.0-103.0 °C; $[\alpha]_D^{20}$ = - 28.6 (c 1.22, $CHCl_3$);

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.43 (s, 3 H), 3.75 (s, 3 H), 5.53 (d, 1 H, J = 8.0 Hz), 6.03 (d, 1 H, J = 8.0 Hz), 6.45 (s, 1 H), 6.88-6.91 (m, 2 H), 6.98-7.01 (m, 2 H), 7.08-7.12 (m, 6 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 13.7, 51.6, 66.1, 80.9, 101.3, 114.8, 126.4, 127.6, 128.3, 128.57, 128.60, 128.8, 133.8, 133.9, 141.9, 155.0, 155.5, 164.2;

IR (film) cm^{-1} 2982(m), 1752(s), 1711(s), 1631(w), 1585(m), 1439(m), 1463(s);

mass spectrum (APCI): m/e (% relative intensity) 378.2 (38) $(M + H)^+$, 334.2 (100).



35

Using Iodonium Ylide: 2-Amido-Furan **35** (46.6 mg, 0.117 mmol) was isolated in 39% yield from ynamide **21** (86.2 mg, 0.302 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **35** (24.9 mg, 0.062 mmol) was isolated in 31% yield from ynamide **21** (58.0 mg, 0.203 mmol) according to the general procedure.

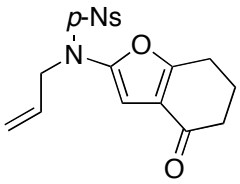
35: R_f = 0.23 [20% EtOAc in hexanes]; mp 98.0-104.0 °C;

^{1}H NMR (500 MHz, $CDCl_3$) δ 2.42 (s, 3 H), 2.45 (s, 3 H), 3.75 (s, 3 H), 4.61 (s, 2 H), 6.25 (s, 1 H), 7.20-7.26 (m, 5 H), 7.30-7.32 (m, 2 H), 7.65-7.66 (m, 2 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 14.0, 21.9, 51.6, 54.2, 108.4, 114.5, 128.0, 128.2, 128.7, 128.8, 130.0, 135.4, 135.9, 143.5, 144.5, 157.5, 164.1;

IR (film) cm^{-1} 2984(m), 1715(s), 1619(w), 1599(w), 1577(w), 1498(w), 1441(m), 1353(s);

mass spectrum (APCI): m/e (% relative intensity) 400.1 (100) $(M + H)^+$.



36

Using Diazo Compounds: 2-Amido-Furan **36** (16.4 mg, 0.044 mmol) was isolated in 29% yield from ynamide **23a** (40.0 mg, 0.15 mmol) according to the general procedure.

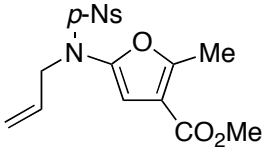
36: R_f = 0.14 [25% EtOAc in hexanes]; mp 117.5-120.5 °C;

^{1}H NMR (500 MHz, $CDCl_3$) δ 2.19 (tt, 2 H, J = 6.5, 6.5 Hz), 2.50 (t, 2 H, J = 6.5 Hz), 2.81 (t, 2 H, J = 6.5 Hz), 4.15 (d, 2 H, J = 6.5 Hz), 5.17-5.20 (m, 2 H), 5.73 (ddt, 1 H, J = 6.5, 10.0, 17.0 Hz), 6.38(s, 1 H), 7.98-8.01 (m, 2 H), 8.37-8.40 (m, 2 H);

^{13}C NMR (125 MHz, $CDCl_3$) δ 22.5, 23.4, 37.6, 54.1, 104.5, 120.7, 122.4, 124.7, 129.3, 131.3, 144.7, 145.2, 150.7, 165.4, 193.8;

IR (film) cm^{-1} 3106(w), 2981(s), 2971(s), 2929(m), 1737(s) 1676(m), 1613(w), 1571(w), 1520(m), 1454(m), 1433(m), 1353(s);

mass spectrum (APCI): m/e (% relative intensity) 377.1 (100) $(M + H)^+$.



37

Using Iodonium Ylide: 2-Amido-Furan **37** (43.6 mg, 0.115 mmol) was isolated in 38% yield from ynamide **23a** (80.0 mg, 0.30 mmol) according to the general procedure.

Using Diazo Compounds: 2-Amido-Furan **37** (31.3 mg, 0.082 mmol) was isolated in 41% yield from ynamide **23a** (53.3 mg, 0.20 mmol) according to the general procedure.

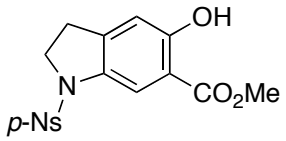
37: R_f = 0.35 [25% EtOAc in hexanes]; mp 90.0-95.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.49 (s, 3 H), 3.82 (s 3 H), 4.13 (dt, 2 H, J = 1.2, 6.4 Hz), 5.15-5.21 (m, 2 H), 5.74 (ddt, 1 H, J = 6.4, 10.0, 16.8 Hz), 6.44 (s, 1 H), 7.96-7.99 (m, 2 H), 8.36-8.39 (m, 2 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 13.9, 51.7, 53.7, 108.9, 114.7, 120.4, 124.5, 129.2, 131.4, 142.4, 144.8, 150.6, 157.9, 163.8;
IR (film) cm^{-1} 3104(w), 2981(m), 1738(s), 1719(s), 1607(w), 1573(w), 1532(m), 1443(m), 1352(s);
mass spectrum (APCI): m/e (% relative intensity) 381.1 (100) $(M + H)^+$.

General Procedure for the Diels-Alder Cycloaddition.

A solution 2-amino-furan **27b** [18.0 mg] in toluene [1.1 mL] was placed in a Sealed Tube and heated at 160 ^oC for 20 h. When the reaction was complete, the mixture was filtered through a pad of Celite^{TM} and concentrated *in vacuo*. The crude residue was purified by silica gel flash column chromatography.

CHARACTERIZATIONS.

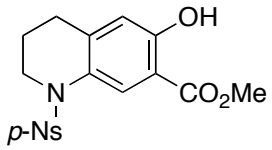


38

38 (13.4 mg, 0.035 mmol) was isolated in 81% yield from 2-amido-furan **27b** (18.0 mg, 0.044 mmol) according to the general procedure.

38: R_f = 0.2 [25% EtOAc in hexanes]; mp 218.0-222.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.85 (t, 2 H, J = 8.0 Hz), 3.96 (t, 2 H, J = 8.0 Hz), 4.01 (s, 3 H), 6.74 (s, 1 H), 7.93-7.95 (m, 2 H), 8.06 (s, 1 H), 8.29-8.31 (m, 2 H), 10.84 (s, 1 H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 28.6, 50.3, 52.9, 111.3, 114.9, 115.8, 124.6, 128.6, 133.3, 141.4, 142.6, 150.7, 160.0, 170.5;
IR (film) cm^{-1} 3103(w), 2958(w), 1729(w) 1677(m), 1623(w), 1605(w), 1534(s), 1476(m), 1439(m), 1400(w);
mass spectrum (ESI): m/e (% relative intensity) 377.0 (20) $(M - H)^-$, 186.0 (100).



39

39 (12.0 mg, 0.031 mmol) was isolated in 73% yield from 2-amido-furan **27c** (17.7 mg, 0.042 mmol) according to the general procedure.

39: R_f = 0.26 [25% EtOAc in hexanes]; mp 182.0-186.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.61 (tt, 2 H, J = 6.4, 6.4 Hz), 2.32 (t, 2 H, J = 6.4 Hz), 3.81 (t, 2 H, J = 6.4 Hz), 3.99 (s, 3 H), 6.66 (s, 1 H), 7.72-7.75 (m, 2 H), 8.25-8.28 (m, 3 H), 10.71 (s, 1 H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 21.7, 26.9, 46.7, 52.8, 111.4, 117.5, 124.5, 127.4, 127.7, 128.6, 140.8, 145.2, 150.4, 159.4, 170.3;

IR (film) cm^{-1} 3112(w), 2983(m), 2929(m), 1732(w) 1680(m), 1611(w), 1539(s), 1491(m), 1441(s);

mass spectrum (APCI): m/e (% relative intensity) 393.1 (15) $(M + H)^+$, 207.1 (100).