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A Practical Gold-Catalyzed Route to 4-Substituted Oxazolidin-2-ones from *N*-Boc Propargylamines

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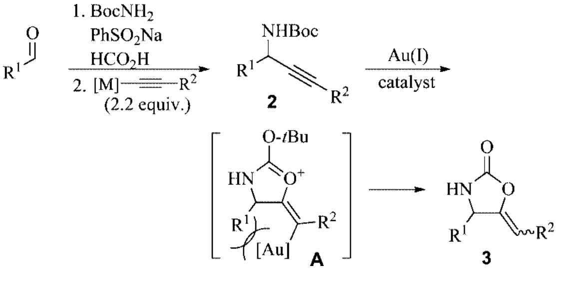
Au^I-catalyzed cyclization of *N*-Boc propargylamines into 4-alkylidene oxazolidin-2-ones is described. This modular approach provides access to a variety of nonproteogenic 4-substituted oxazolidinones that are important in asymmetric synthesis and biological applications. The current flexible route is characterized by low catalyst loading, mild conditions, and operational simplicity.

Introduction

Oxazolidin-2-ones with substituents at the 4-position are one of the most versatile and widely used chiral auxiliaries in organic synthesis, and unabated efforts have been made to utilize this structural motif in a variety of asymmetric transformations.[1] Over the recent years, oxazolidinone derivatives have also attracted considerable attention as antibacterial agents, as represented by Linezolid (Pfizer).[2] Particularly, 4-substituted oxazolidinone derivatives have promising biological applications, such as cytokine modulator and cholesterol lowering agents, as well as interesting properties in RNA binding and peptidomimetics.[3] Therefore, a flexible and modular protocol generating structurally diverse 4-substituted oxazolidinone analogs is of current interest in terms of its asymmetric synthesis and biological applications.

The traditional route towards oxazolidin-2-ones involves the reaction of 1,2-amino alcohol derivatives with phosgene.[4a] A number of approaches toward nonproteogenic oxazolidinones have also been developed, including epoxide ring opening, aminohydroxylation of alkenes, and electrochemical or Pd-catalyzed reaction of propargylamine with CO_2.[4b–4d] However, these methods often involve several steps, harsh conditions, or are operationally cumbersome. In this report, we disclose a Au^I-catalyzed route toward 4-substituted-5-alkylidene-oxazolidin-2-ones from *N*-Boc propargylamines, which is characterized by mild conditions, exceptionally low catalyst loading, and operational simplicity.

In the course of our investigation on gold-catalyzed activation of C–C multiple bonds for the formation of C–N and C–O bonds,[5] we and others reported that *O*-Boc (homo)propargyl alcohols efficiently cyclize into cyclic enol carbonates under Au^I catalysis.[5c,5d] We projected an extension of this cyclization mode to *N*-Boc propargylamine as a simple and efficient protocol for the synthesis of 4-substituted-5-alkylidene-oxazolidin-2-ones (Scheme 1).[6] During the preparation of this manuscript, Carretero et al. and Gagosz et al. independently reported such a transformation, each working on differently substituted substrates (Figure 1).[6b,6c] Herein, we report our own study on the cyclization of *N*-Boc propargylamines leading to the identification of factors affecting the rates of cyclization and discuss the intriguing isomerization mechanism found for internal alkyne substrates.



Scheme 1. Au^I-catalyzed route to 4-substituted-5-alkylidene-oxazolidinone.

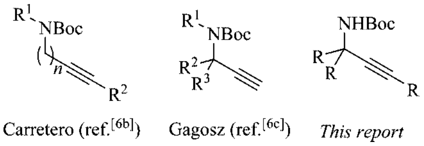


Figure 1. Substrates used in this study.

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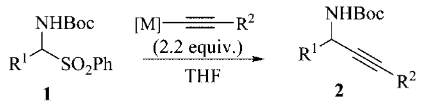
Results and Discussion

We commenced our study with the preparation of *N*-Boc protected α-aryl- and alkyl-substituted propargylamines by the direct addition of the alkyne into imine equivalents. However, *N*-Boc imines **2** having an aliphatic R^1 group has only scarce precedents owing to its facile tautomerization into the corresponding enamine under basic conditions.[7] Therefore, the one-pot procedure of Petrini, which involves the addition of 2.2 equiv. of an alkynyl Grignard reagent to readily available sulfones **1**,[8] was best-suited for the preparation of various *N*-Boc propargylamines **2a**–**r** with aromatic as well as aliphatic R^1 substituents (Scheme 2).



2a R^1 = 1-naph, R^2 = H, 76 %
2b R^1 = 2-naph, R^2 = H, 85 %
2c R^1 = 2-furyl, R^2 = H, 73 %
2d R^1 = 2-thienyl, R^2 = H, 75 %
2e R^1 = *p*-MeO-Ph, R^2 = H, 90 %
2f R^1 = *m*-MeO-Ph, R^2 = H, 91 %
2g R^1 = Ph, R^2 = H, 86 %
2h R^1 = *p*-MeO_2C-Ph, R^2 = H, 73 %
2i R^1 = *p*-NC-Ph, R^2 = H, 71 %
2j R^1 = *i*Pr, R^2 = H, 83 %
2k R^1 = *c*-C_6H_{11}, R^2 = H, 90 %
2l R^1 = *t*Bu, R^2 = H, 70 %
2m R^1 = Bn, R^2 = H, 77 %
2n R^1 = Ph, R^2 = Ph, 94 %
2o R^1 = Ph, R^2 = *n*Bu, 86 %
2p R^1 = *i*Pr, R^2 = Ph, 97 %
2q R^1 = Ph, R^2 = *t*Bu, 64 %
2r R^1 = *p*-MeO-Ph, R^2 = Ph, 91 %

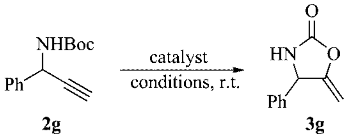
Scheme 2. One-pot preparation of *N*-Boc propargylamines; alkynylmagnesium reagents ($R^2 \neq H$) were prepared by treating the terminal alkynes with *n*BuLi, followed by $MgBr_2{\cdot}OEt_2$.

In view of the mechanism for the cyclization of **2**, a vinyl–Au^I intermediate such as **A** can be expected as a result of the *trans* addition across the triple bond (Scheme 1).[11] Presumably, **A** would suffer from significant unfavorable allylic 1,3-interaction that develops between the propargylic substituent (R^1) and the Au-moiety bearing ligand. This rate reduction can also be aggravated by the population of the unfavored rotamer in the absence of N-substituents in **2**.[6c]

Therefore, we undertook an extensive optimization study by using **2g** as the substrate, and the selected data are shown in Table 1.[9] In terms of the ligand on Au, sterically demanding ligands seemed to have a detrimental effect, which is in agreement with allylic strain, and a change in the electronic nature of ligand did not improve the yields (Table 1, Entries 3–6). Gratifyingly, the efficiency of the catalyst was highly dependent on the counteranion of gold (Table 1, Entries 6–10). While BF_4^-, ClO_4^-, and NTf_2^- as counteranions showed a marginal improvement, the TfO^- complex turned out to be highly effective, giving **3g** quantitatively in 30 min at room temp. and 1 mol-% catalyst loading (Table 1, Entry 10). THF, toluene, and DCM were all appropriate solvents, with toluene giving the highest rate and a 94% yield of **3g** in 3 h with the use of only 0.5 mol-% of the $Au(PPh_3)OTf$ complex at room temp.

With the optimized reaction conditions, we next investigated the scope of the current cyclization by using *N*-Boc propargylamines **2a**–**m** and **2s**–**u** having a terminal acetylene moiety (Table 2). For example, substrates having various aromatic and heteroaromatic substituents with varying electronic demand at R^1 underwent clean reactions (Table 2, Entries 1–8). The aliphatic substrates also underwent a clean reaction, although they required the use of 1–5 mol-% of catalyst (Table 2, Entries 9–12). There was a noticeable decrease in the reaction rate with increasing steric bulk of R^1 (Table 2, Entries 9–12). For example, **2l** required 5 mol-% of catalyst at 50 °C for a reasonable conversion. However, *gem*-disubstituted substrates **2s** and **2t** underwent a rapid reaction with the use of 0.5 mol-% of the catalyst (Table 2, Entries 13 and 14), with the help of

Table 1. Optimization of the cyclization.



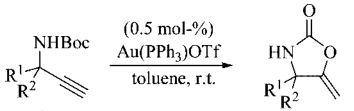
2g **3g**

Entry	Catalyst (loading)[a]	Solvent	Time	Yield [%][b]
1	AuCl (1%)	DCE	24 h	<5
2	$AuCl_3$ (1%)	DCE	24 h	7
3	$Au[P(C_6F_5)_3]SbF_6$ (1%)	DCE	24 h	43
4	Au[P{(*t*Bu)$_2$biphenyl}]SbF_6 (1%)	DCE	24 h	59
5	Au[P(*o*-tol)$_3$]SbF_6 (1%)	DCE	13 h	>99
6	$Au(PPh_3)SbF_6$ (1%)	DCE	8 h	>99
7	$Au(PPh_3)BF_4$ (1%)	DCE	2 h	3
8	$Au(PPh_3)ClO_4$ (1%)	DCE	2 h	10
9	$Au(PPh_3)NTf_2$ (1%)	DCE	2 h	24
10	$Au(PPh_3)OTf$ (1%)	DCE	30 min	>99
11	$Au(PPh_3)OTf$ (1%)	THF	5 min	>99
12	$Au(PPh_3)OTf$ (1%)	toluene	5 min	>99
13	$Au(PPh_3)OTf$ (1%)	DCM	5 min	>99
14	$Au(PPh_3)OTf$ (0.5%)	toluene	1 h	94

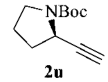
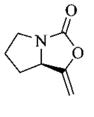
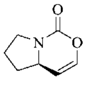
[a] Catalyst was prepared in situ by mixing $Au(PR_3)Cl$ and Ag salt. [b] GLC yields.

Thorpe–Ingold effect. Interestingly for proline-derived amine **2u**, the reaction gave a mixture of 5-*exo* and 6-*endo* products **3ua** and **3ub** in 53 and 17% yield, respectively (Table 2, Entry 15), which is in contrast to that reported by Gagosz.[6c]

Table 2. Cyclization of substrates with terminal acetylene.[a]



2a–u → **3a–u**

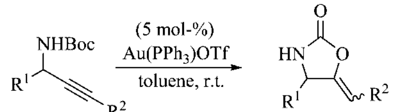
Entry	Substrate (R^1, R^2)	Time	Yield [%][b]
1	**2a** (1-naphth, H)	50 min	90
2	**2b** (2-naphth, H)	30 min	95
3	**2c** (2-furyl, H)	30 min	91
4	**2d** (2-thienyl, H)	30 min	93
5	**2e** (*p*-MeOPh, H)	30 min	89
6	**2f** (*m*-MeOPh, H)	30 min	96
7	**2h** (*p*- MeO_2CPh, H)	1 h	94
8	**2i** (*p*-NCPh, H)	30 min	98
9	**2j** (*i*Pr, H)	2 h	77[c]
10	**2k** (*c*-C_6H_{11}, H)	2 h	87[c]
11	**2l** (*t*Bu, H)	2 h	85[d]
12	**2m** ($PhCH_2$, H)	30 min	89[c]
13	**2s** (Et, Et)	10 min	91
14	**2t** ($CH_2(CH)_3CH_2$)	40 min	87
15	 **2u**	12 h	 **3ua** 53  **3ub**[e] 17

[a] The catalyst was formed in situ from $Au(PPh_3)OTf$ (0.5 mol-%) in toluene (0.2 M) at room temp. unless otherwise noted. [b] Isolated yields after chromatography. [c] At 1 mol-% catalyst loading. [d] At 50 °C and 5 mol-% catalyst loading. [e] At 5 mol-% catalyst loading.

Next, we tested substrates **2n–r** that have an internal acetylene unit; these substrates underwent a much slower reaction (Table 3). Unexpectedly, in this case we found that a mixture of geometric isomers was produced. For instance, reaction of **2n** produced a chromatographically separable mixture of (*Z*)-**3n** and (*E*)-**3n** in a ratio of 2.6:1 (Table 3, Entry 1) in 97% combined yield and other substrates gave the corresponding oxazolidinones with varying ratios of (*Z*/*E*).[10] When isomers (*Z*)-**3n** and (*E*)-**3n** were separated and subjected again to the reaction conditions [$Au(PPh_3)$-OTf (5 mol-%) in toluene at 50 °C], we recovered only the respective starting isomers even after 10 h without noticeable isomerization, indicating that the ratio of (*Z*/*E*) isomers is not the result of thermodynamic equilibration of the products. The formation of (*E*)-**3** was surprising, considering that the related substrate with *N*-substitution produced only the (*Z*) isomers as a result of the *trans* addition to the alkyne that was activated by gold.[6b,11]

With the intent to clarify the mechanism for the production of (*E*)-**3**, which is the apparent *cis* addition product, we prepared N-allyl substrate **2v** (Table 3, Entry 6). In this case, there was a noticeable increase in the (*Z*/*E*) ratio (from 7.3:1 for **3p** to 9.3:1 for **3v**). On the basis of this observation, we postulate the isomerization mechanism depicted in Scheme 3. Especially in the case of substrates without an N-substituent (R = H), cationic vinyl–Au intermediate **A** would partly undergo proton shift to form imine form **C**, which isomerizes into **A′** to relieve the allylic strain. It is noteworthy that the (*E*) geometry of **3** might play an interesting role in defining the steric environment of the 4-substituted oxazolidinone.

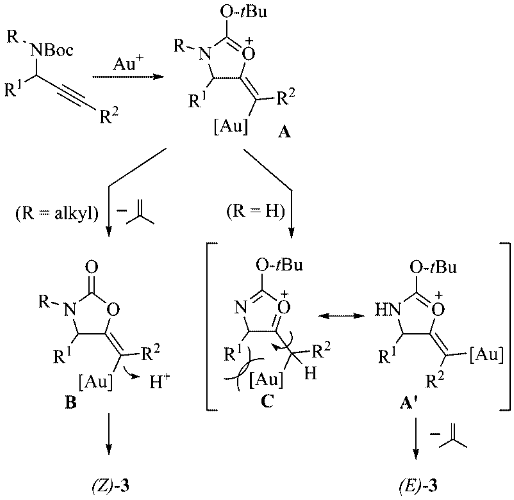
Table 3. Cyclization of substrates with an internal acetylene unit.



2n–r → **3n–r**

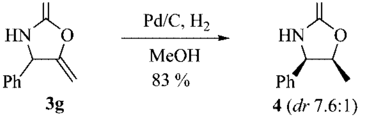
Entry	Substrate (R^1, R^2)	Time	Yield [%][a] (*Z*/*E*)
1	**2n** (Ph, Ph)	12 h	97 (2.6:1)
2	**2o** (Ph, *n*Bu)	4 h	93 (8.3:1)
3	**2p** (*i*Pr, Ph)	12 h	99 (7.3:1)
4	**2q** (Ph, *t*Bu)	2 h	85 (4.9:1)
5	**2r** (*p*MeO-Ph, Ph)	3 h	93 (3.2:1)
6	**2v**	3 h	92 (9.3:1)

[a] (*Z*/*E*) isomers were cleanly separated by chromatography and the combined yield is indicated.

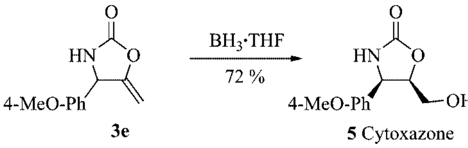


Scheme 3. Proposed mechanistic model for the isomerization reaction.

The utility of the 4-substituted-5-methylene-oxazolidon-2-ones was briefly examined as in Equation (1) and Equation (2). Diastereoselective hydrogenation of **3g** in the presence of Pd on charcoal gave saturated oxazolidinone **4** in 83% yield (*dr* 7.6:1) and the hydroboration of **3e** underwent smoothly to give cytoxazone **5** in 72% yield, which is a potent natural cytokine modulator.[12]



(1)



(2)

Conclusions

An efficient and general route toward 4-substituted-5-alkylidene-oxazolidin-2-ones is reported by modular assembly of aldehydes and alkynes through a Au^I-catalyzed cyclization. This procedure allows diverse modification of oxazolidinones for steric and electronic tuning, which would find fruitful applications in asymmetric synthesis, especially when coupled with asymmetric preparations.[13] A very low catalyst loading is a further practical merit of the current protocol in view of the economical consideration. Further work aimed at the utilization of (*E*)-**3n–v** as chiral auxiliaries is currently underway in this laboratory.

Experimental Section

General: All reactions were performed in oven-dried glassware under an argon atmosphere with freshly distilled solvents. All other commercially available reagents (Aldrich) were used without further purification. ^{1}H and ^{13}C NMR spectra were acquired with a Varian 400 MHz (Mercury) spectrometer. Chemical shifts are reported relative to chloroform for ^{1}H NMR (7.26 ppm) and ^{13}C NMR (77.0 ppm) spectroscopy. Elemental analyses were performed with a Thermo Flash EA1102 Series instrument at Sogang University, Seoul, Korea. Infrared spectra were recorded with a Jasco Model FTIR-480 Plus spectrometer.

Representative Procedure for the Preparation of *N*-Boc Propargylamines (2a–r): To a solution of phenylacetylene (176 mg, 1.73 mmol) in tetrahydrofuran (3.6 mL) cooled to 0 °C was added *n*BuLi (2.5 M in hexane, 0.69 mL, 1.73 mmol) under an Ar atmosphere. The reaction mixture was stirred at 0 °C for 30 min and magnesium bromide diethyl ether (446.7 mg, 1.73 mmol) was added to the solution. Subsequently, **1g** (200 mg, 0.57 mmol) in THF (1 mL) was added to the above mixture at 0 °C, and the mixture was slowly warmed to room temp. over 2 hr. A saturated solution of NH_4Cl (5 mL) was added, and the aqueous layer was extracted with diethyl ether (3 × 10 mL). The organic layers were combined and dried with $MgSO_4$. After removal of solvent in vacuo, the resulting oil was purified by silica gel chromatography (EtOAc/hexane, 1:10) to provide 165.7 mg (94%) of **2n** as a pale yellow solid.

2n: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.46 (s, 9 H), 5.21 (br. s, 1 H), 5.90 (br. d, *J* = 6.9 Hz, 1 H), 7.27–7.31 (m, 4 H), 7.34–7.38 (m, 2 H), 7.44–7.46 (m, 2 H), 7.56 (d, *J* = 7.3 Hz, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.2, 46.7, 80.1, 84.6, 87.4, 122.5, 126.8, 127.9, 128.2, 128.3, 128.5, 131.6, 139.4, 154.7 ppm.

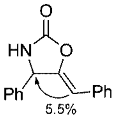
Representative Procedure for the Cyclization of 2a–v: To a solution of $Au(PPh_3)Cl$ (1.3 mg, 0.0025 mmol) and AgOTf (0.65 mg, 0.0025 mmol) in toluene (2.5 mL) was added **2a** (140 mg, 0.5 mmol) at room temperature, and the reaction mixture was stirred at room temp. for 50 min. After removal of solvent in vacuo, the residue was purified by silica gel chromatography (EtOAc/hexane, 1:3) to provide 102 mg (90%) of **3a** as a pale yellow solid. For other substrates, refer to Tables 2 and 3 for catalyst loading and conditions.

3a: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 4.19 (dd, *J* = 2.2, 3.3 Hz, 1 H), 4.75–4.76 (m, H), 6.17 (br. s, 1 H), 6.38 (br. s, 1 H), 7.41–7.60 (m, 4 H), 7.84–8.00 (m, 3 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 56.8, 88.4, 122.3, 124.8, 125.4, 126.1, 127.0, 129.2, 129.6, 130.4, 133.5, 134.1, 155.1, 156.3 ppm. IR (CH_2Cl_2): $\tilde{\nu}$ = 1673, 1777 cm^{-1}. $C_{14}H_{11}NO_2$ (225.24): calcd. C 74.65, H 4.92, N 6.22; found C 73.64, H 5.14, N 5.81.

3ua: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.58–1.72 (m, 1 H), 1.96–2.28 (m, 3 H), 3.23 (ddd, *J* = 4.4, 6.9, 11.3 Hz, 1 H), 3.61–3.67 (m, 1 H), 4.32 (dd, *J* = 1.8, 3.3 Hz, 1 H), 4.36–4.44 (m, 1 H), 4.73 (dd, *J* = 2.2, 2.9 Hz, 1 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 26.0, 31.8, 45.8, 62.3, 86.7, 154.7, 158.6 ppm. IR (CH_2Cl_2): $\tilde{\nu}$ = 1678, 1787 cm^{-1}. $C_7H_9NO_2$ (139.15): calcd. C 60.42, H 6.52; found C 60.47, H 6.75.

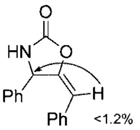
3ub: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.58–1.72 (m, 2 H), 1.78–1.92 (m, 2 H), 1.96–2.08 (m, 2 H), 2.11–2.22 (m, 1 H), 3.45 (ddd, *J* = 3.0, 9.5, 12.4 Hz, 1 H), 3.72 (td, *J* = 8.4, 11.8 Hz, 1 H), 4.07–4.11 (m, 1 H), 5.22 (dd, *J* = 1.8, 6.2 Hz, 1 H), 6.40 (dd, *J* = 2.2, 5.9 Hz, 1 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.7, 32.9, 45.7, 55.7, 103.6, 139.6, 149.5 ppm. $C_7H_9NO_2$ (139.15): calcd. C 60.42, H 6.52; found: C 60.16, H 6.83.

(*Z*)-3n: IR (CH_2Cl_2): $\tilde{\nu}$ = 1688, 1763 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.30 (d, *J* = 1.8 Hz, H, vinyl), 5.53 (s, H, NC*H*), 5.84 (br. s, H, N*H*), 7.18–7.28 (m, H), 7.30–7.38 (m, 2 H), 7.38–7.52 (m, 6 H), 7.52–7.64 (m, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 60.6, 104.8, 127.0, 127.0, 128.3, 128.4, 129.21, 129.27, 133.1, 138.7, 148.8, 155.9 ppm. $C_{16}H_{13}NO_2$ (251.28): calcd. C 76.48, H 5.21, N 5.57; found C 76.2, H 5.18, N 4.98. nOe correlation:



(*Z*)-**3n**

(*E*)-3n: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.25–5.28 (m, 1 H, vinyl), 5.62 (dd, *J* = 1.8, 3.6 Hz, 1 H, NC*H*), 5.68 (br. s, 1 H, N*H*), 7.28–7.46 (m, 7 H), 7.60–7.74 (m, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 55.8, 98.6, 124.7, 126.6 128.4, 128.7, 129.1, 129.4, 131.4, 141.3, 147.5, 150.1 ppm. nOe correlation:



(*E*)-**3n**

Preparation and Cyclization of *N*,*N*-Allyl-Boc Propargylamine 2v: To a solution of **2p** (100.0 mg, 0.365 mmol) in anhydrous DMF (1 mL) at 0 °C was added NaH (60% dispersion in mineral oil, 17.6 mg, 0.0.439 mmol). When gas evolution ceased, allyl bromide (66.4 mg, 0.549 mmol) was added, and the mixture was warmed to room temperature over 4 h. To the reaction was added water (5 mL) and the aqueous layer was extracted with Et_2O (3 × 5 mL). The combined organic layer was dried ($MgSO_4$), filtered, and the solvents evaporated. The residue was purified by chromatography (EtOAc/Hexane, 1:6) to give **2v** (101.4 mg, 89%) as a colorless oil. To a vial containing $Au(PPh_3)Cl$ (5.1 mg, 0.010 mmol) and AgOTf (2.7 mg, 0.010 mmol) was added a solution of **2v** (71.0 mg, 0.210 mmol) in toluene (0.4 mL), and the mixture was allowed to stir at room temp. for 3 h. The crude ^{1}H NMR spectrum indicated an isomeric ratio of 90.3:9.7 for *Z*/*E* isomers. Chromatographic separation of the crude mixture gave 44.7 mg of (*Z*)-**3v** (44.7 mg) and (*E*)-**3v** (4.8 mg) with a combined yield of 92%.

2v: ^{1}H NMR (400 MHz, $CDCl_3$, mixture of rotamers at room temp.): δ = 0.96 (d, J = 6.6 Hz, 3 H), 1.11 (d, J = 6.6 Hz, 1 H), 1.45 (s, 9 H), 2.01 (m, 1 H), 3.96 (br. s, 2 H), 4.59, 4.89 (two br. s, each from major and minor rotamers, 1 H, NC*H*), 5.10 (br. d, J = 10.2 Hz, 1 H), 5.20 (br. d, J = 15.4 Hz, 1 H), 5.97 (br. m, 1 H), 7.27–7.32 (m, 3 H), 7.35–7.41 (m, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 19.1, 19.6, 28.3, 32.8, 47.2, 54.9, 79.9, 84.9, 87.3, 115.9, 123.0, 128.0, 128.2, 131.5, 135.8, 155.4 ppm.

(*Z*)-3v: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.92 (d, J = 6.9 Hz, 3 H), 1.07 (d, J = 6.9 Hz, 3 H), 2.15 (m, 1 H), 3.62 (dd, J = 7.7, 15.7 Hz, 1 H), 4.30 (dd, J = 1.8, 2.9 Hz, 1 H), 4.34 (tdd, J = 1.8, 4.8, 15.7 Hz, 1 H), 5.28 (br. d, J = 11.4 Hz, 1 H), 5.28 (d, J = 16.5 Hz, 1 H), 5.49 (d, J = 1.5 Hz, 1 H), 5.79 (m, 1 H), 7.18–7.24 (m, 1 H), 7.30–7.36 (m, 2 H), 7.56–7.61 (m, 2 H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 15.4, 17.4, 44.5, 63.5, 104.4, 119.1, 126.8, 128.4, 131.4, 133.4, 144.8, 155.2 ppm.

Hydrogenation of Oxazolidinone 3g: To a solution of **3g** (30 mg, 0.17 mmol) in methanol (2 mL) was added Pd/C (10 wt.-%, 36 mg, 0.0034 mmol) and H_2 gas was bubbled from a balloon at room temperature. After 3 h, the reaction mixture was filtered through a pad of Celite and washed with MeOH (4 mL) and diethyl ether (4 mL). The combined organic phase was dried with $MgSO_4$. After removal of the solvent in vacuo, the resulting oil was purified by silica gel chromatography (EtOAc/hexane, 1:4) to provide 25 mg (83% yield; *syn*/*anti*, 87:13) of **4**[14] as a white solid.

Hydroboration of Oxazolidinone 3e: To a solution of **3e** (19 mg, 0.095 mmol) in THF (1 mL) was added $BH_3\cdot THF$ (1 M, 168 µL, 0.17 mmol) dropwise at 0 °C, and the reaction mixture was stirred at 50 °C for 1 h followed by oxidation with NaOH (2 M, 1 mL) and H_2O_2 (30%, 1 mL). The aqueous layer was extracted with diethyl ether (3 × 2 mL), and the combined organic layer was dried with $MgSO_4$. After removal of solvent in vacuo, the resulting oil was purified by silica gel chromatography (CH_2Cl_2/MeOH, 6:1) to provide 14.8 mg (72%) of **5**.[12b]

Supporting Information (see footnote on the first page of this article): Compound characterization data for **2a**–**r** and **3b**–**t**, ^{1}H and ^{13}C NMR spectra for all enlisted new compounds.

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