Copper Catalyzed Regio- and Stereoselective Hydroarylation of Ynamide

Avijit Maity,[a] *and Akhila K. Sahoo*[*a]

School of Chemistry, University of Hyderabad, Hyderabad, India-500046
E-mail: akssc@uohyd.ac.in, akhilchemistry12@gmail.com

KEYWORDS: Cu-catalysis • sustainable process • stereoselectivity • hydro-arylation • enamide

ABSTRACT: Presented herein is a copper-catalyzed *trans*-hydroarylation of ynamides. The reaction showcases the assembly of boronic acids across the carbon-carbon triple bond of ynamides. The reaction proceeds under mild conditions offering a complementary approach for the versatile synthesis of multifunctional (*E*)–α,β–disubstituted enamides. Moreover, the hydroarylation process is highly regio- and stereoselective. The transformation shows broad scope (30 examples) and tolerates wide range of labile functional groups. Control experiments provide substantive evidence supporting the mechanistic cycle and the observed selectivity.

INTRODUCTION

Ynamides are unique structural entities that combines the inherent reactivity of alkynes with the polarizing characteristics of amides.[1] The ynamide nitrogen functionality amplifies the synthetic versatility, facilitating the formation of various nitrogen-containing compounds. In this regard, the hydroarylation of ynamides represents a noteworthy method for accessing trisubstituted enamides.[2,3] These enamides serve as adaptable intermediates in organic synthesis and constitute a fundamental structural motif found in numerous natural products and biologically significant molecules.[4]

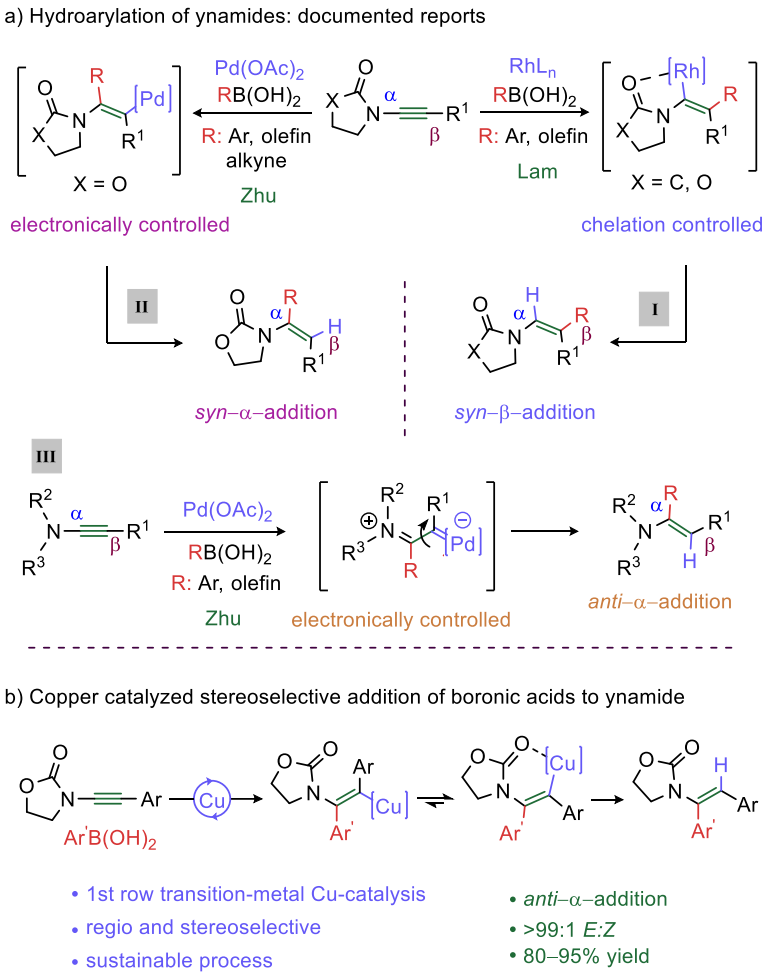


Figure 1. Previous reports and the current strategy

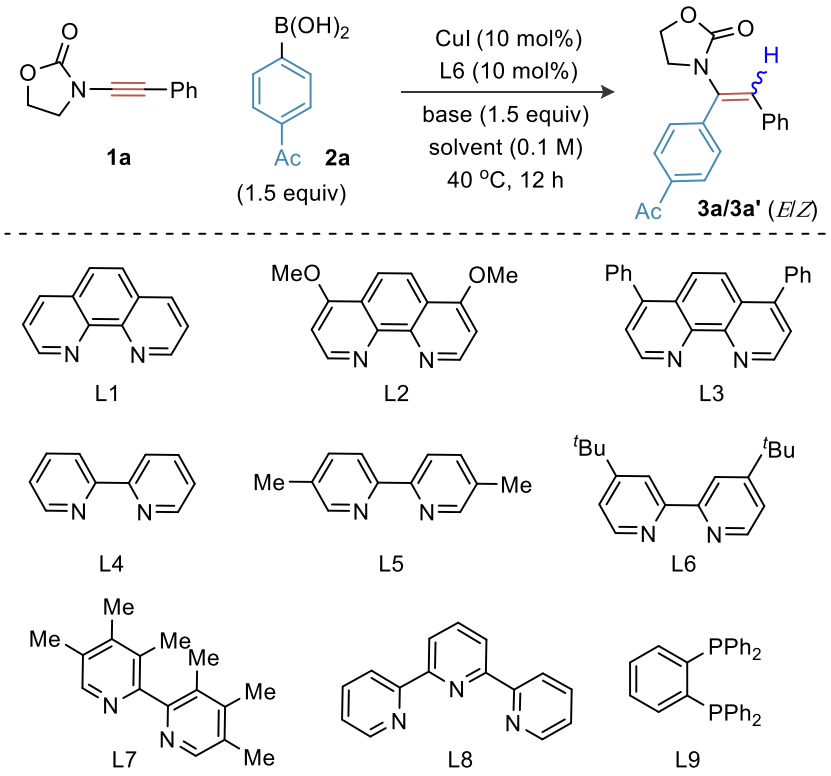
In this context, achieving precise control over the regio- and stereoselective outcomes of hydroarylation is of significant importance to ensure the synthetic relevance of this process. Previous studies on hydroarylation of ynamides have employed two key strategies to govern the selectivity of the reactions. The first approach involves utilizing the coordinating ability of the N-protecting group towards a metal catalyst (Figure 1a–I), while the second strategy relies on leveraging the inherent polarization of the ynamide triple bond (Figure 1a–II). In this regard, Lam and co-workers accomplished an exquisite Rh-catalyzed *syn*-hydroarylation of ynamides with boronic acids [incorporation of functional group (R) at the β-position] under microwave irradiation by taking advantage of the coordination between oxygen and rhodium-species and produced *(E)*–β,β′–disubstituted enamides (Figure 1a–I).[5] On the other hand, an electronically controlled

syn-addition of boronic acids to the ynamides was successful when the reaction was performed under Pd-catalysis (Zhu and colleagues), giving (*Z*)–α,β–disubstituted enamides [incorporation of functional group (R) at the α-position] (Figure 1a–II).[6] In contrast, a stereospecific *anti*-hydroarylation of ynamides through α-addition of boronic acids was reported by the same group under Pd-catalysis, producing (*E*)–α,β–disubstituted enamides (Figure 1a–III).[7] While *syn*-hydroarylation is anticipated in transition-metal (TM) catalysis due to the favorable nature of *syn*-carbometallation, the attainment of the corresponding *anti*-reactivity remains a captivating endeavor. In this context, the pioneering studies on hydroarylation of ynamide have mostly relied on the use of costly second-row transition metal catalysts such as Pd and Rh; harsh reaction conditions are typically required.[5–8] Consequently, there is a growing demand for the developemnt of alternate synthetic process for the hydroarylation of ynamide under mild and sustainable conditions using earth-abundant first-row transition metal catalysts like Cu.[9] In this study, we present a Cu-catalyzed hydroarylation for ynamides employing easily accessible aryl boronic acids (Figure 1b). We surmise that the co-ordination ability of copper could lead to the unusual *anti*-addition of boronic acids to ynamide (Figure 1b). Notably, this protocol circumvents the need for harsh reaction conditions and expensive metal catalyst. The approach demonstrates remarkable efficiency and stereoselectivity, affording (*E*)–α,β–disubstituted enamides (Figure 1b).

RESULTS AND DISCUSSION

The investigation was initiated with the systematic examination of reaction variables pertaining to the hydroarylation of ynamide (**1a**) with 4-acetylphenylboronic acid (**2a**); the results are delineated in Table 1. A series of ligands were subjected to screening in conjunction with a CuI catalyst, Ag_2CO_3 base in dichloromethane (CH_2Cl_2) solvent. The use of 1,10-phenanthroline ligand, despite its limited stereoselectivity, resulted in the production of 66% of **3a** (*E*)/**3a′** (*Z*) [80/20] (Table 1, entry 1). Two alternative phenanthroline derivatives having significant steric hindrance were also examined (entries 2 and 3); however, the outcomes achieved were only moderate. Subsequently, the reaction in the presence of bipyridyl ligand (entries 4, 5, 6, and 7) proved out to be better, leading to an improvement in both yield (up to 95%) and stereoselectivity (*E*/*Z* = >99/01]. Notably, the bulky 4,4'-di-*tert*-butyl-2,2'-bipyridine (**L6**) ligand exhibited a high level of efficacy, yielding the desired enamide **3a** (95%; >99:1 *E*:*Z*) in excellent yield and stereoselectivity (entry 6).

Table 1. Optimization of the reaction conditions[a,b,c]

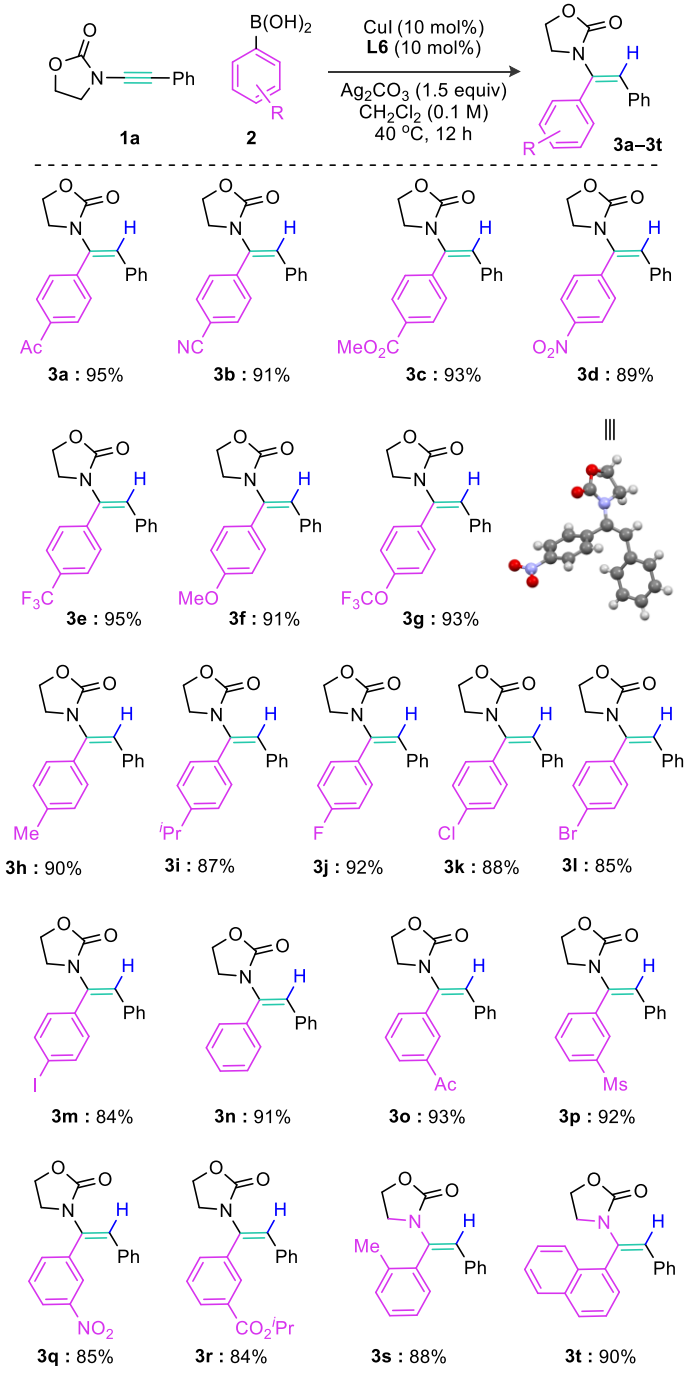


Entry	Ligand	Catalyst	Solvent	Base	Yield of 3a/3a′[b]	(*E*/*Z*)[c]
1	L1	CuI	CH_2Cl_2	Ag_2CO_3	66%	80:20
2	L2	CuI	CH_2Cl_2	Ag_2CO_3	30%	83:17
3	L3	CuI	CH_2Cl_2	Ag_2CO_3	50%	82:18
4	L4	CuI	CH_2Cl_2	Ag_2CO_3	87%	91:9
5	L5	CuI	CH_2Cl_2	Ag_2CO_3	73%	93:7
6	**L6**	**CuI**	**CH_2Cl_2**	**Ag_2CO_3**	**95%**	**>99:1**
7	L7	CuI	CH_2Cl_2	Ag_2CO_3	60%	>99:1
8	L8	CuI	CH_2Cl_2	Ag_2CO_3	trace	–
9	L9	CuI	CH_2Cl_2	Ag_2CO_3	00%	–
10	L6	CuCl	CH_2Cl_2	Ag_2CO_3	73%	98:2
11	L6	CuBr	CH_2Cl_2	Ag_2CO_3	77%	99:1
12	L6	CuI	toluene	Ag_2CO_3	60%	98:2
13	L6	CuI	$ClCH_2CH_2Cl$	Ag_2CO_3	49%	>99:1
14	L6	CuI	PhCl	Ag_2CO_3	80%	>99:1
15	L6	CuI	CH_2Cl_2	AgOAc	62%	>99:1
16	L6	CuI	CH_2Cl_2	K_2CO_3	89%	97:3
17	L6	CuI	CH_2Cl_2	–	trace	–
18	–	CuI	CH_2Cl_2	Ag_2CO_3	trace	–

[a]Reaction Condition: **1a** (0.2 mmol), **2a** (0.3 mmol), Cu-catalyst (10 mol%), ligand (10 mol%), base (0.3 mmol), solvent (0.1M), at 40 °C for 12 h. [b]isolated yield. [c]diastereomeric (*E*/*Z*) ratio was calculated using ^{1}H-NMR of the crude reaction mixture.

By contrast, the tridentate terpyridine ligand L8 was ineffective (entry 8), delivering **3a** in trace. The reaction exhibited no discernible activity when conducted in the presence of a phosphorous ligand (entry 9). Among the ligands screened, L6 was noticed best. The use of other copper catalysts, such as CuCl and CuBr in combination with L6 ligand (entries 10 and 11) were found inferior. We, next, exmined the solvents role; comparable product yield was observed when the reaction was performed in toluene, 1,2-dichloroethan (DCE), and PhCl (entries 12−14). Instead Ag_2CO_3 base, the reaction in the presence of AgOAc or K_2CO_3 was found moderate (entries 15 and 16). Moreover, the reaction was unsuccessful in the absence of either base or ligand L6 (entries 17 and 18).

Scheme 1. Scope of aryl-boronic acids[a,b,c]

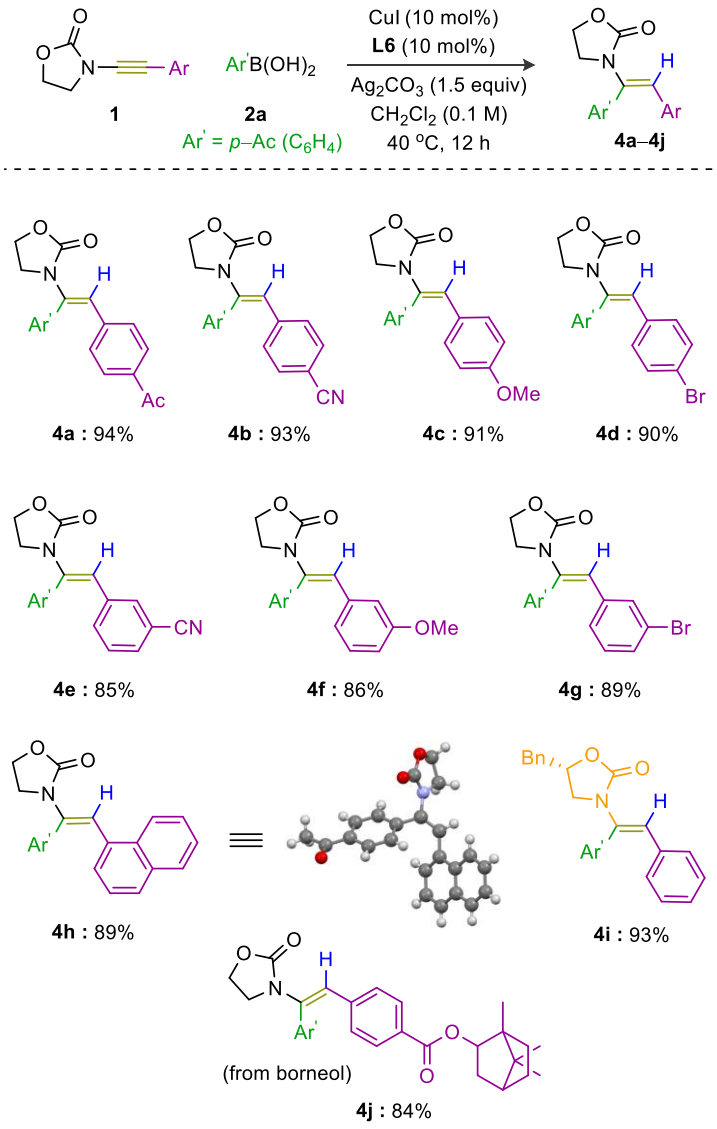


[a]Reaction Condition: **1a** (0.2 mmol), **2** (0.3 mmol), CuI (10 mol%), **L6** (10 mol%), Ag_2CO_3 (0.3 mmol), CH_2Cl_2 (0.1M), at 40 °C for 12 h; [b]isolated yield, [c]diastereomeric (*E*:*Z*) ratio was calculated using ^{1}H-NMR of crude reaction mixture.

With optimized conditions in hand, the reaction scope was then investigated. To start with, the generality of aryl boronic acids was explored in the *trans*-hydroarylation process of ynamide **1a**

(Scheme 1). The aryl boronic acids bearing electron-withdrawing *p*-substituents (*p*-Ac, *p*-CN, *p*-CO_2Me, *p*-NO_2, and *p*-CF_3), exhibited good compatibility as coupling partners, yielding the desired hydroarylation products **3a–e** (89–95%). The reaction is *trans*-selective; the single crystal X-ray analysis of **3d** confirms the molecular topology. Subsequently, excellent yields (87–93%) of the products **3f–i** were observed when electron-rich (*p*-OMe, *p*-OCF_3, *p*-Me, and *p*-^{i}Pr) substituted aryl boronic acids participated in the coupling reaction. Notably, the reaction in presence of the low-valent copper catalyst exhibited good tolerance to the labile and modifiable halo-groups in the aryl boronic acids; the desired products **3j–m** with F/Cl/Br/I groups on the molecular periphery are made in excellent yields. Even the electron-neutral phenylboronic acid reacted well affording **3n** in 91% yield. Moreover, the reaction of aryl boronic acids possessing *meta*-substituents (*m*-Ac, *m*-Ms, *m*-NO_2, and *m*-$CO_2{}^i$Pr) led to the desired enamides **3o–r** in good to excellent yields (84–93%). Intriguingly, the *ortho*-substituted sterically bulky 2-tolyl boronic acid and 1-naphthyl boronic acid reacted well without affecting the selectivity and productivity; the desired products **3s** and **3t** are isolated in 88% and 90% yields, respectively.

Scheme 2. Scope of ynamides[a,b,c]

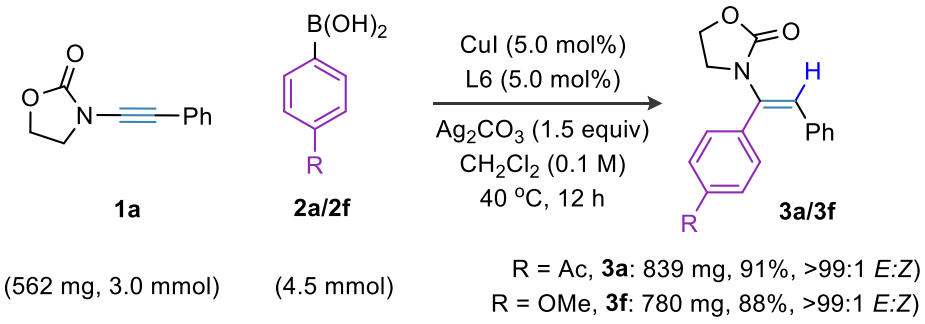


[a]Reaction Condition: **1** (0.2 mmol), **2a** (0.3 mmol), CuI (10 mol%), **L6** (10 mol%), Ag_2CO_3 (0.3 mmol), CH_2Cl_2 (0.1M), at 40 °C for 12 h; [b]isolated yield, [c]diastereomeric (*E*:*Z*) ratio was calculated using ^{1}H-NMR of crude reaction mixture.

We, next, examined to assess the potential of ynamides reactivity in conjunction with 4-acyl benzene boronic acid **2a** (Scheme 2). Ynamides containing an aryl group at the terminus, encompassing both electron-withdrawing and electron-donating *para*-substituents (*p*-Ac, *p*-CN, and *p*-OMe) led to the desired products **4a**–**c** (91–94%) in excellent isolated yields. Notably, the presence of a labile and adaptable *p*-bromo substitution did not impede the efficiency; the desired enamide **4d** was isolated in 90% yield. Furthermore, the incorporation of *meta*-substituents (*m*-CN, *m*-OMe, and *m*-Br) on the aryl group had no detrimental effect, yielding the respective tri-

substituted enamides **4e–g** in good yields. Intriguingly, even the inclusion of a bulky polyaromatic 1-naphthyl substitution in the ynamide terminus was compatible; **4h** was made in 89% yield with a diastereoselectivity favoring the *trans*-isomer in a ratio exceeding 99:1 (*E:Z*). The structure of **4h** was once again validated by X-ray diffraction analysis. To our delight, introduction of bulkier benzyl substituent in the oxazolidinone ring did not exhibit any discernible influence on the yield and selectivity; the compound **4i** (93%) was made. Nevertheless, the reaction of biologically relevant borneol-derived ynamide was also successful, constructing **4j** in 84% yield.

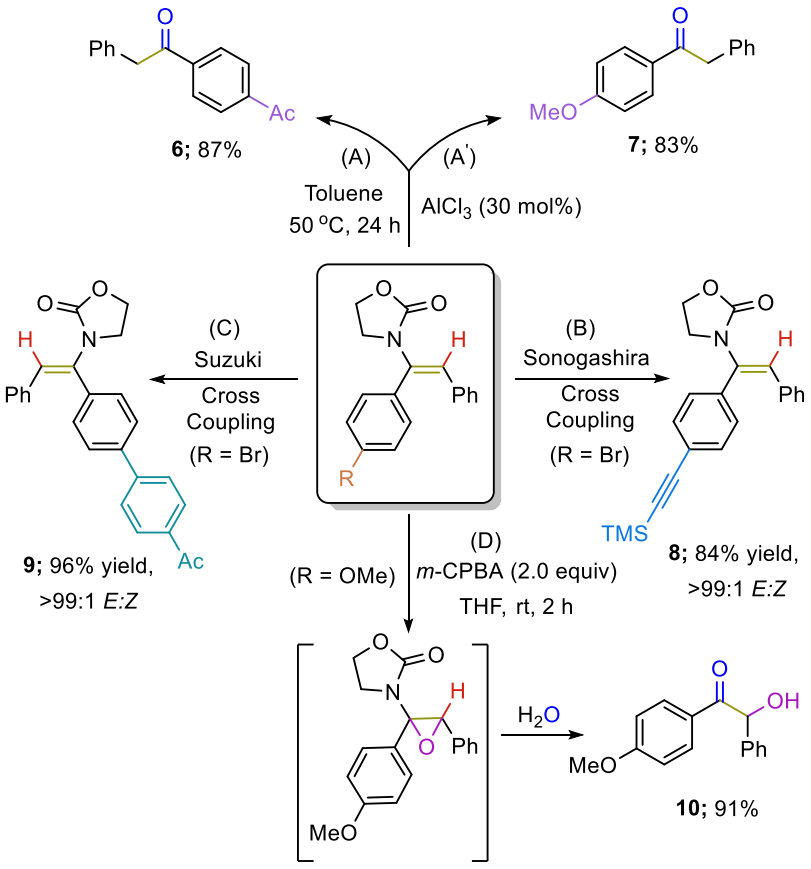
Scheme 3. Gram scale synthesis[a,b,c]



[a]Reaction Condition: **1a** (3.0 mmol), **2a/2f** (4.5 mmol), CuI (5.0 mol%), **L6** (5.0 mol%), Ag_2CO_3 (4.5 mmol), CH_2Cl_2 (0.1M), at 40 °C for 12 h; [b]isolated yield, [c]diastereomeric (*E*:*Z*) ratio was calculated using ^{1}H-NMR of crude reaction mixture.

In order to upscale the reaction, the reaction of **1a** (562 mg, 3.0 mmol) with **2a** (738 mg, 4.5 mmol) was performed in presence of 5.0 mol% CuI and **L6** ligand (Scheme 3). The desired (*E*)–α,β–disubstituted enamide **3a** (839 mg) was obtained in 91% yield. Likewise, **3f** (780 mg, 88%) was made from the reaction between **1a** (562 mg, 3.0 mmol) with **2f** (684 mg, 4.5 mmol). Importantly, the selectivity of the reaction remained unaffected, thus providing robust evidence for the synthetic applicability and potential of this transformation.

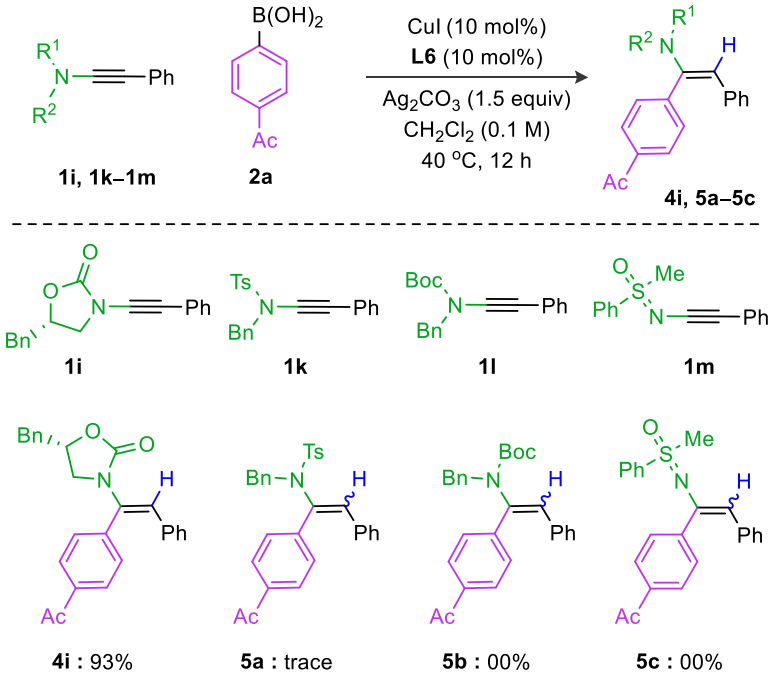
Scheme 4. Synthetic applications[a,b,c]



[a]Reaction Conditions; (A): **3a** (0.2 mmol), $AlCl_3$ (30 mol%), toluene (0.1M) at 50 °C for 24 h; (A'): **3f** (0.2 mmol), $AlCl_3$ (30 mol%), toluene (0.1M) at 50 °C for 24 h; (B): **3l** (0.2 mmol), $Pd(PPh_3)_2Cl_2$ (4.0 mol%), CuI (6.0 mol%), trimethylsilylacetylene (0.3 mmol), Et_3N (2.0 mmol) at 90 °C for overnight; (C): **3l** (0.2 mmol), $Pd(OAc)_2$ (10 mol%), tris(*o*-tolyl)phosphine (20 mol%), K_2CO_3 (0.6 mmol), 1,4-dioxane:water (9:1, 0.2M) at reflux for overnight; (D): **3f** (0.2 mmol), *m*-CPBA (0.4 mmol), THF (0.1M) at room temperature for 2 h. [b]isolated yield, [c]diastereomeric (*E*:*Z*) ratio was calculated using ^{1}H-NMR of crude reaction mixture.

Next, the synthetic potential of trisubstituted enamides has been investigated (Scheme 4). The $AlCl_3$ mediated hydration of enamides **3a** and **3f** resulted in the formation of respective carbonyl compounds **6** (87%) and **7 (**83%). Gratifyingly, the hydration was facilitated by the elimination of the oxazolidinone ring, which was recovered and subsequently reused. The Pd-catalyzed Sonogashira[10] and Suzuki cross-coupling[11] of bromo-substituted enamide **3l** with trimethylsilylacetylene and 4-acetylphenylboronic acid yielded compound **8** (84%) and **9** (96%), respectively; the selectivity remains unaffected. Interestingly, epoxidation of the sterically dense trisubstituted olefin **3f** followed by water attack, led to the formation of α–hydroxy ketone **10** in 91% yield.[12]

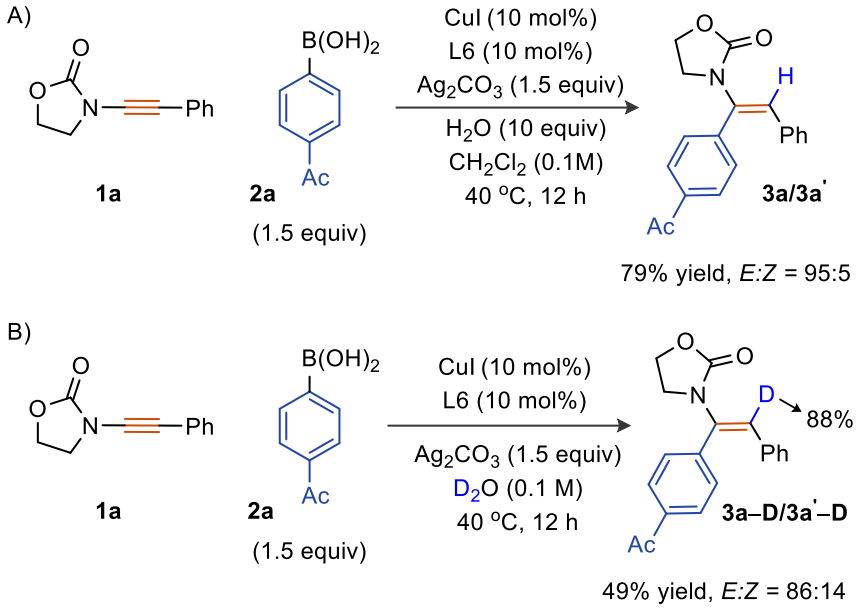
Scheme 5. Control experiments (N-protecting group screening)[a,b]



[a]Reaction Condition: **1i**, **1k-1m** (0.2 mmol), **2a** (0.3 mmol), CuI (10 mol%), **L6** (10 mol%), Ag_2CO_3 (0.3 mmol), CH_2Cl_2 (0.1M), at 40 °C for 12 h; [b]isolated yield.

In order to gain valuable insights into the underlying reaction mechanism, a series of control experiments were conducted (Scheme 5). Initially, the significance of various N-protecting groups in ynamides was thoroughly assessed. Intriguingly, the inclusion of a bulky benzyl group in the oxazolidinone ring did not exert any significant influence on the overall yield or stereochemical outcome of the reaction (**1i**→**4i**, 93%). Conversely the compounds **1k–m** with diverse arrays of N-Ts, N-Boc or N-sulfonamide coordinating groups distinct from the oxazolidinone ring when independently subjected to the optimized reaction conditions, no formation of anticipated hydroarylated products **5a–c** was detected (Scheme 5). These findings strongly suggest the existence of a coordination between the carbonyl oxygen atom of the oxazolidinone ring and the vinylic copper species.

Scheme 6. Control experiments (isotope levelling studies)[a,b,c]



[a]Reaction Condition; (A) **1a** (0.2 mmol), **2a** (0.3 mmol), CuI (10 mol%), **L6** (10 mol%), Ag_2CO_3 (0.3 mmol), H_2O (2.0 mmol), CH_2Cl_2 (0.1M) at 40 °C for 12 h; (B) **1a** (0.2 mmol), **2a** (0.3 mmol), CuI (10 mol%), **L6** (10 mol%), Ag_2CO_3 (0.3 mmol), D_2O (0.1M) at 40 °C for 12 h. [b]isolated yield, [c]diastereomeric (*E*:*Z*) ratio was calculated using ^{1}H-NMR of crude reaction mixture.

To elucidate the proton source involved in the protodemetalation step, the reaction of **1a** with **2a** was performed under the optimized conditions in the presence of water (10 equiv); the product **3a** (*E*)/**3a′** (*Z*) [95/5] was obtained in 79% yield (Scheme 6A). The formation of other isomer is perhaps due to the difficulty in the possible coordination between copper and the oxazolidinone amide oxygen moiety when the reaction was performed in polar protic solvent. To further validate the role of proton source in the reaction, an experiment was conducted in the presence of deuterated water (D_2O) solvent (Scheme 6B). Notably, the deuterated tetra-substituted enamide **3a–D** (*E*) /**3a′–D** (*Z*) was formed in 49% yield in 86:14 ratio with 88% incorporation of deuterium. This provides compelling evidence that adventitious moisture present in the solvent is sufficiently capable to catalyze the protodemetalation process.

PLAUSIBLE MECHANISM

Based on the findings from control experiments and previous reports,[9] a plausible reaction mechanism has been proposed (Figure 2). The interaction between CuI and ligand **L6** at first makes the active catalyst **A**.[13] Next, transmetalation of the aryl boronate species with the ligated active

Cu(I) catalyst results in the formation of intermediate **B**. Subsequently, intermediate **B** undergoes a *syn* carbo-cupration,[14] attacking at the electron-deficient α–position of the ynamide to produce intermediate **C**. Notably, the probable coordination between copper and the oxazolidinone amide oxygen atom is thermodynamically favorable; this helps the formation of intermediate **D** through isomerization of intermediate **C**. Finally, protodecupration of intermediate **D** forms the desired product with the regeneration of the active catalyst **A** (Figure 2).

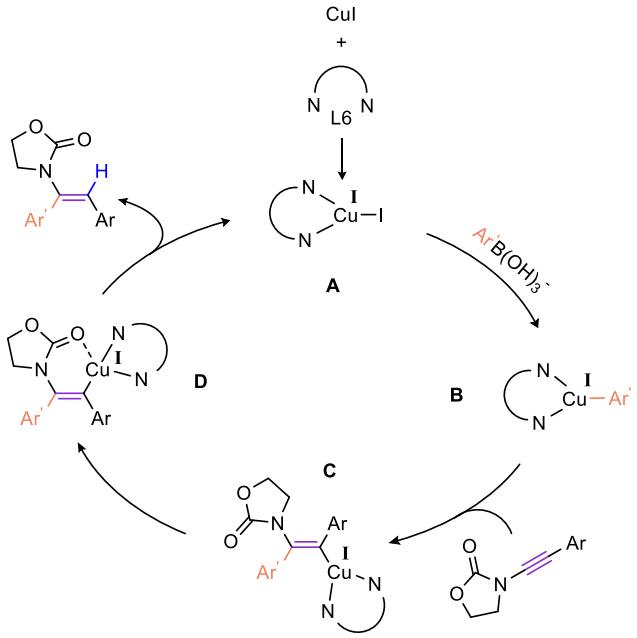


Figure 2. Plausible mechanism

CONCLUSION

In summary, we have successfully established a Cu-catalyzed regio- and stereoselective hydroarylation of ynamides. The protocol demonstrates broad functional group tolerance, accommodating diverse aryl boronic acids and ynamides. Notably, the use of an earth-abundant copper catalyst enhances the sustainability of the process. This straightforward and direct approach provides a highly useful means to access (*E*)–α,β–disubstituted enamides from readily accessible starting materials. The post-modifications of the synthesized enamides further emphasize their synthetic utility.

EXPERIMENTAL SECTION

General Information

All the reactions were performed in an oven-dried sealed tubes. Commercial grade solvents were distilled prior to use. Column chromatography was performed using either 100–200 Mesh silica gel or neutral alumina. Thin layer chromatography (TLC) was performed on silica gel GF254 plates. Proton, carbon, and fluorine nuclear magnetic resonance spectra (^{1}H NMR, ^{13}C NMR, and ^{19}F NMR) were recorded based on the resonating frequencies as follows: (^{1}H NMR, 400 MHz; ^{13}C NMR, 101 MHz; ^{19}F NMR, 376 MHz) and (^{1}H NMR, 500 MHz; ^{13}C NMR, 126 MHz; ^{19}F NMR, 471 MHz) having the solvent resonance as internal standard (^{1}H NMR, $CDCl_3$ at 7.26 ppm, DMSO D_6 at 2.51 ppm; ^{13}C NMR, $CDCl_3$ at 77.0 ppm, DMSO D_6 at 39.8 ppm). Data for ^{1}H NMR are reported as follows: chemical shift (ppm), multiplicity (s = singlet; br s= broad singlet; d = doublet; br d = broad doublet, t = triplet; q = quartet; m = multiplet; dt = doublet of triplet; td = triplet of doublet; dd = doublet of doublet; tt = triplet of triplet), coupling constants, *J*, in (Hz), and integration. Data for ^{13}C NMR, ^{19}F NMR are reported in terms of chemical shift (ppm). IR spectra are reported in cm^{-1}. High resolution mass spectra are obtained in ESI mode. Melting points are determined by electro-thermal heating and are uncorrected. X-ray data was collected at 293 K using graphite monochromated Mo-Kα radiation (0.71073 Å).

Materials: Unless otherwise noted, all the reagents and intermediates were obtained commercially and used without purification. Toluene, $ClCH_2CH_2Cl$ (DCE), CH_2Cl_2 (DCM), chlorobenzene, and $CHCl_3$ were distilled over CaH_2 and dry THF was used as received. Aryl boronic acids, Cu-catalysts and other reagents were purchased from commercially available sources and directly used without purification. Following the known procedures, ynamides **1a–1m** were synthesized.[16] Analytical and spectral data of all the known compounds are exactly matching with the reported values.

General procedure for the synthesis of 1 (GP-1):[15]

To a mixture of amide (2.0 mmol), $CuSO_4 \cdot 5H_2O$ (38.1 mg, 0.2 mmol), 1,10-phenanthroline (72.1 mg, 0.4 mmol), and K_2CO_3 (5.5 gm, 4.0 mmol) in dry toluene (8.0 mL) was added 1-bromo-2-

arylacetylene (2.4 mmol). The reaction mixture was heated at 80 ºC under nitrogen atmosphere. Progress of the reaction was monitored periodically by TLC. Upon completion, the reaction mixture was cooled to room temperature and diluted with dichloromethane (10 mL). The crude mixture was filtered through a small pad of celite and concentrated under reduced pressure. The crude residue was purified using column chromatography on silica gel to obtain **1a–m**.

Synthesis of (2R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yl 4-((2-oxooxazolidin-3-yl)ethynyl)benzoate (1j):[15, 16]

Following the known procedure, ynamide **1j** was synthesized from 2.0 mmol of 2-oxazolidone as colorless solid in 59% yield; mp = 184–186 ºC; R_f = 0.5 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, J = 8.5 Hz, 2H), 7.46 (d, J = 8.5 Hz, 2H), 5.08 (dt, J = 9.5, 3.0 Hz, 1H), 4.49 (t, J = 8.5 Hz, 2H), 4.02 (t, J = 8.0 Hz, 2H), 2.50–2.39 (m, 1H), 2.13–2.05 (m, 1H), 1.84–1.73 (m, 1H), 1.71 (t, J = 4.5 Hz, 1H), 1.44–1.35 (m, 1H), 1.34–1.24 (m, 1H), 1.09 (dd, J = 14.0, 3.5 Hz, 1H), 0.94 (s, 3H), 0.89 (s, 3H), 0.885 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 166.1, 155.6, 130.9, 129.9, 129.3, 126.8, 81.8, 80.7, 71.0, 63.1, 49.0, 47.8, 46.9, 44.9, 36.8, 28.0, 27.3, 19.6, 18.8, 13.5; IR (Neat) ν_{max} 2949, 2259, 1762, 1702, 1607, 1417, 1273, 1194, 1161, 1090, 975, 846, 745 cm^{-1}; **HRMS (ESI)** for $C_{22}H_{25}NNaO_4^+$ $(M+Na)^+$: calcd. 390.1676, found 390.1678.

General procedure for hydroarylation of ynamides (GP-2):

To a mixture of ynamide **1** (0.2 mmol), aryl boronic acid **2** (0.3 mmol), CuI (3.8 mg, 10 mol%), **L6** (5.4 mg, 10 mol%), Ag_2CO_3 (83 mg, 0.3 mmol) in an oven-dried 15 mL sealed tube was added CH_2Cl_2 (2.0 mL, 0.1M). The mixture was stirred at 40 ºC for 12 h. The reaction progress was periodically monitored by TLC. After complete consumption of ynamide, the crude residue was filtered through a small pad of Celite and rinsed with CH_2Cl_2 (5×2.0 mL). Excess aryl boronic acid **2** was removed by washing with 10 mL saturated $NaHCO_3$ solution and the organic layer was extracted using CH_2Cl_2 (3×5.0 mL). The combined organic layers were concentrated and the crude reaction mixture was purified by chromatography on neutral alumina using hexane/ethyl acetate (4:1) as an eluent to isolate the desired product **3a**–**3t & 4a**–**4j**.

(*E*)-3-(1-(4-Acetylphenyl)-2-phenylvinyl)oxazolidin-2-one (3a)

Following the general procedure **GP-2**, compound **3a** (59 mg) was obtained in 95% yield as colorless solid; mp = 143–145 °C; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (400 MHz, DMSO D_6) δ 7.92 (dt, J = 8.8, 2.0 Hz, 2H), 7.43 (dt, J = 8.8, 2.0 Hz, 2H), 7.19–7.08 (m, 3H), 6.95 (d, J = 8.4 Hz, 2H), 6.71 (s, 1H), 4.40 (t, J = 7.6 Hz, 2H), 3.82 (t, J = 8.4 Hz, 2H), 2.58 (s, 3H); ^{13}C{^{1}H} NMR (101 MHz, DMSO D_6) δ 197.7, 155.6, 139.8, 137.2, 136.3, 135.8, 130.2, 129.2, 128.7, 128.6, 127.3, 121.8, 62.3, 46.7, 27.0; IR (Neat) ν_{max} 2974, 1744, 1677, 1396, 1263, 1037, 845, 750 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{18}NO_3^+$ $(M+H)^+$: calcd. 308.1281, found 308.1278.

(*E*)-4-(1-(2-Oxooxazolidin-3-yl)-2-phenylvinyl)benzonitrile (3b):

Following the general procedure **GP-2**, compound **3b** (53 mg) was obtained in 91% yield as colorless solid; mp = 163–165 °C; R_f = 0.2 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.80 (d, J = 8.0 Hz, 2H), 7.47 (d, J = 8.0 Hz, 2H), 7.20–7.10 (m, 3H), 6.91 (d, J = 7.5 Hz, 2H), 6.69 (s, 1H), 4.41 (t, J = 8.0 Hz, 2H), 3.89 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (101 MHz, DMSO D_6) δ 155.4, 140.0, 135.8, 135.5, 132.8, 130.9, 129.3, 128.7, 127.4, 121.2, 119.1, 111.4, 62.5, 46.8; IR (Neat) ν_{max} 2918, 2224, 1752, 1393, 1165, 1036, 848, 755 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{14}N_2NaO_2^+$ $(M+Na)^+$: calcd. 313.0947, found 313.0946.

Methyl (*E*)-4-(1-(2-oxooxazolidin-3-yl)-2-phenylvinyl)benzoate (3c):

Following the general procedure **GP-2**, compound **3c** (60 mg) was obtained in 93% yield as pale yellow liquid; R_f = 0.5 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.92 (dt, J = 8.5, 2.0 Hz, 2H), 7.43 (dt, J = 8.5, 2.0 Hz, 2H), 7.18–7.08 (m, 3H), 6.92 (d, J = 7.5 Hz, 2H), 6.69 (s, 1H), 4.39 (t, J = 8.5 Hz, 2H), 3.85 (s, 3H), 3.83 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 166.4, 155.5, 139.8, 136.1, 135.6, 130.2. 128.84, 129.78, 129.2, 128.6, 127.2, 121.1, 62.4, 52.7, 46.6; IR (Neat) ν_{max} 2952, 1747, 1714, 1395, 1272, 1102, 1038, 715 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{17}NNaO_4^+$ $(M+Na)^+$: calcd. 346.1050, found 346.1051.

(*E*)-3-(1-(4-Nitrophenyl)-2-phenylvinyl)oxazolidin-2-one (3d):

Following the general procedure **GP-2**, compound **3d** (55 mg) was obtained in 89% yield as yellow solid; mp = 148–150 °C; R_f = 0.3 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15 (dt, J = 9.0, 2.5 Hz, 2H), 7.46 (dt, J = 9.0, 2.0 Hz, 2H), 7.16–7.10 (m, 3H), 6.96–6.90 (m, 2H), 6.73 (s, 1H), 4.44 (t, J = 8.0 Hz, 2H), 3.81 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 155.5,

147.7, 141.2, 134.5, 134.3, 130.5, 129.1, 128.3, 127.5, 123.8, 123.7, 61.7, 46.2; IR (Neat) ν_{max} 2919, 2210, 1743, 1512, 1414, 1340, 1237, 1107, 1033, 852, 756 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{14}N_2NaO_4^+$ $(M+Na)^+$: calcd. 333.0846, found 333.0848.

(*E*)-3-(2-Phenyl-1-(4-(trifluoromethyl)phenyl)vinyl)oxazolidin-2-one (3e):

Following the general procedure **GP-2**, compound **3e** (63 mg) was obtained in 95% yield as colorless liquid; R_f = 0.7 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.70 (d, J = 8.0, Hz, 2H), 7.50 (d, J = 8.0 Hz, 2H), 7.19–7.08 (m, 3H), 6.93 (d, J = 7.0 Hz, 2H), 6.71 (s, 1H), 4.40 (t, J = 8.0 Hz, 2H), 3.86 (t, J = 8.0 Hz, 2H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 155.4, 139.2, 135.9, 135.6, 130.7, 129.2, 129.1 (q, J = 32 Hz, 1C), 128.7, 127.3, 125.8 (q, J = 3.8 Hz, 2C), 124.6 (q, J = 272 Hz, 1C), 121.1, 62.4, 46.7; $^{19}F\{^1H\}$ NMR (471 MHz, DMSO D_6) δ –61.1; IR (Neat) ν_{max} 1678, 2982, 1747, 1446, 1320, 1107, 1060, 818, 727 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{15}NF_3NO_2^+$ $(M+H)^+$: calcd. 334.1049, found 334.1048.

(*E*)-3-(1-(4-Methoxyphenyl)-2-phenylvinyl)oxazolidin-2-one (3f):

Following the general procedure **GP-2**, compound **3f** (54 mg) was obtained in 91% yield as pale yellow gummy liquid; R_f = 0.2 (30% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.20 (dt, J = 9.0, 2.5 Hz, 2H), 7.16–7.11 (m, 2H), 7.10–7.06 (m, 1H), 6.95 (d, J = 7.5 Hz, 2H), 6.92 (dt, J = 9.0, 3.0 Hz, 2H), 6.62 (s, 1H), 4.34 (t, J = 8.0 Hz, 2H), 3.77 (s, 3H), 3.68 (t, J = 8.0 Hz, 2H); $^{13}C\{^1H\}$ NMR (101 MHz, DMSO D_6) δ 159.9, 155.7, 136.6, 136.4, 131.1, 129.1, 128.6, 126.8, 120.2, 114.6, 62.1, 55.6, 46.5; IR (Neat) ν_{max} 2910, 1743, 1510, 1394, 1245, 1151, 1027, 838, 722 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{18}NO_3^+$ $(M+H)^+$: calcd. 296.1281, found 296.1286.

(*E*)-3-(2-Phenyl-1-(4-(trifluoromethoxy)phenyl)vinyl)oxazolidin-2-one (3g):

Following the general procedure **GP-2**, compound **3g** (65 mg) was obtained in 93% yield as colorless liquid; R_f = 0.6 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.40 (dt, J = 9.0, 2.5 Hz, 2H), 7.33 (d, J = 8.5 Hz, 2H), 7.17–7.08 (m, 3H), 6.91 (d, J = 7.0 Hz, 2H), 6.67 (s, 1H), 4.38 (t, J = 8.0 Hz, 2H), 3.81 (t, J = 8.0 Hz, 2H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 155.5, 148.7, 135.84, 135.77, 134.1, 131.9, 129.1, 128.6, 127.1, 121.4, 120.6, 120.5 (q, J = 257 Hz, 1C), 62.3, 46.6; $^{19}F\{^1H\}$ NMR (471 MHz, DMSO D_6) δ -56.9; IR (Neat) ν_{max} 2901, 1745, 1507, 1397,

1151, 853, 754 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{14}F_3NNaO_3^+$ $(M+Na)^+$: calcd. 372.0818, found 372.0818.

(*E*)-3-(2-Phenyl-1-(*p*-tolyl)vinyl)oxazolidin-2-one (3h):

Following the general procedure **GP-2**, compound **3h** (50 mg) was obtained in 90% yield as colorless liquid; R_f = 0.6 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.19–7.14 (m, 4H), 7.14–7.11 (m, 2H), 7.10–7.06 (m, 1H), 6.94 (d, J = 7.5 Hz, 2H), 6.65 (s, 1H), 4.34 (t, J = 8.0 Hz, 2H), 3.68 (t, J = 8.0 Hz, 2H), 2.32 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 155.7, 138.5, 136.8, 136.2, 131.8, 129.8, 129.6, 129.1, 128.5, 126.9, 120.6, 62.1, 46.5, 21.4; IR (Neat) ν_{max} 2915, 1744, 1511, 1394, 1215, 1038, 752 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{18}NO_2^+$ $(M+H)^+$: calcd. 280.1332, found 280.1333.

(*E*)-3-(1-(4-Isopropylphenyl)-2-phenylvinyl)oxazolidin-2-one (3i):

Following the general procedure **GP-2**, compound **3i** (54 mg) was obtained in 87% yield as colorless liquid; R_f = 0.7 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.23 (d, J = 8.0 Hz, 2H), 7.19 (d, J = 8.0 Hz, 2H), 7.14–7.05 (m, 3H), 6.92 (d, J = 8.5 Hz, 2H), 6.67 (s, 1H), 4.34 (t, J = 7.5 Hz, 2H), 3.67 (t, J = 8.0 Hz, 2H), 2.51 (septet, J = 2.0 Hz, 1H), 1.21 (d, J = 7.0 Hz, 6H), $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 155.8, 149.3, 136.7, 136.2, 132.2, 129.6, 129.1, 128.5, 127.0, 126.9, 120.8, 62.1, 46.5, 33.6, 24.2; IR (Neat) ν_{max} 2959, 1746, 1479, 1398, 1216, 1090, 751 cm^{-1}; **HRMS (ESI)** for $C_{20}H_{21}NNaO_2^+$ $(M+Na)^+$: calcd. 330.1465, found 330.1465.

(*E*)-3-(1-(4-Fluorophenyl)-2-phenylvinyl)oxazolidin-2-one (3j):

Following the general procedure **GP-2**, compound **3j** (52 mg) was obtained in 92% yield as colorless liquid; R_f = 0.6 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.34–7.29 (m, 2H), 7.21–7.13 (m, 4H), 7.12–7.07 (m, 1H), 6.91 (d, J = 7.5 Hz, 2H), 6.64 (s, 1H), 4.36 (t, J = 8.0 Hz, 2H), 3.77 (t, J = 8.0 Hz, 2H); $^{13}C\{^1H\}$ NMR (101 MHz, DMSO D_6) δ 162.5 (d, J = 246 Hz, 1C), 155.5, 136.1, 136.0, 132.0 (d, J = 8.0 Hz, 2C), 131.2, 129.1, 128.6, 127.0, 120.3, 116.1 (d, J = 21 Hz, 2C), 62.2, 46.6; $^{19}F\{^1H\}$ NMR (376 MHz, DMSO D_6) δ -112.8; IR (Neat) ν_{max} 2914, 1743, 1628, 1394, 1216, 1089, 842, 753 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{15}FNO_2^+$ $(M+H)^+$: calcd. 284.1081, found 284.1084.

(*E*)-3-(1-(4-Chlorophenyl)-2-phenylvinyl)oxazolidin-2-one (3k):

Following the general procedure **GP-2**, compound **3k** (53 mg) was obtained in 88% yield as colorless liquid; R_f = 0.7 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.40 (dt, J = 8.5, 2.5 Hz, 2H), 7.29 (dt, J = 8.5, 2.5 Hz, 2H), 7.19–7.14 (m, 2H), 7.13–7.08 (m, 1H), 6.94 (d, J = 7.0 Hz, 2H), 6.65 (s, 1H), 4.37 (t, J = 8.0 Hz, 2H), 3.80 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.5, 136.0, 135.8, 133.7, 133.6, 131.7, 129.2, 129.1, 128.7, 127.1, 120.6, 62.3, 46.6; IR (Neat) ν_{max} 2976, 1746, 1635, 1403, 1283, 1093, 845, 705 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{15}ClNO_2^+$ $(M+H)^+$: calcd. 300.0786, found 300.0788.

(*E*)-3-(1-(4-Bromophenyl)-2-phenylvinyl)oxazolidin-2-one (3l):

Following the general procedure **GP-2**, compound **3l** (59 mg) was obtained in 85% yield as pale yellow liquid; R_f = 0.7 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.53 (dt, J = 8.5, 2.5 Hz, 2H), 7.22 (dt, J = 8.5, 2.5 Hz, 2H), 7.18–7.13 (m, 2H), 7.13–7.08 (m, 1H), 6.96–6.91 (m, 2H), 6.64 (s, 1H), 4.36 (t, J = 8.0 Hz, 2H), 3.79 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.5, 136.0, 135.8, 134.1, 132.01, 131.97, 129.2, 128.7, 127.1, 122.2, 120.6, 62.3, 46.6; IR (Neat) ν_{max} 2980, 1742, 1627, 1393, 1281, 1038, 834, 727 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{15}BrNO_2^+$ $(M+H)^+$: calcd. 344.0281, found 344.0281.

(*E*)-3-(1-(4-Iodophenyl)-2-phenylvinyl)oxazolidin-2-one (3m):

Following the general procedure **GP-2**, compound **3m** (66 mg) was obtained in 84% yield as pale red liquid; R_f = 0.7 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.71 (dt, J = 8.5, 2.0 Hz, 2H), 7.18–7.14 (m, 2H), 7.13–7.09 (m, 1H), 7.07 (dt, J = 8.5, 2.0 Hz, 2H), 6.97–6.93 (m, 2H), 6.64 (s, 1H), 4.37 (t, J = 8.0 Hz, 2H), 3.78 (t, J = 8.0 Hz, 2H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.5, 137.9, 136.2, 135.8, 134.4, 131.9, 129.2, 128.7, 127.1, 120.7, 95.5, 62.3, 46.6; IR (Neat) ν_{max} 2908, 1714, 1626, 1393, 1280, 1037, 834, 741 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{14}INNaO_2^+$ $(M+Na)^+$: calcd. 413.9961, found 413.9963.

(*E*)-3-(1,2-Diphenylvinyl)oxazolidin-2-one (3n):

Following the general procedure **GP-2**, compound **3n** (49 mg) was obtained in 91% yield as colorless liquid; R_f = 0.6 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.39–7.34 (m, 3H), 7.31–7.26 (m, 2H), 7.16–7.07 (m, 3H), 6.94–6.89 (m, 2H), 6.67 (s, 1H), 4.35 (t, J = 8.0 Hz, 2H), 3.71 (t, J = 8.5 Hz, 2H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.7, 136.9, 136.1, 134.8,

129.7, 129.1, 128.5, 127.0, 120.6, 62.2, 46.5; IR (Neat) ν_{max} 2907, 1742, 1626, 1478, 1394, 1215, 1038, 754 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{15}NNaO_2^+$ $(M+Na)^+$: calcd. 288.0995, found 288.0999.

(*E*)-3-(1-(3-Acetylphenyl)-2-phenylvinyl)oxazolidin-2-one (3o):

Following the general procedure **GP-2**, compound **3o** (57 mg) was obtained in 93% yield as colorless solid; mp = 154–156 °C; R_f = 0.1 (30% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 7.0, 2.0 Hz, 1H), 7.83 (br t, J = 1.5 Hz, 1H), 7.55–7.46 (m, 2H), 7.14 (t, J = 7.5 Hz, 2H), 7.10 (tt, J = 7.5, 2.5 Hz, 1H), 6.91 (d, J = 7.0 Hz, 2H), 6.69 (s, 1H), 4.39 (t, J = 8.0 Hz, 2H), 3.82 (t, J = 8.0 Hz, 2H), 2.51 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 198.0, 155.5, 137.5, 136.4, 135.8, 135.3, 134.6, 129.5, 129.3, 129.2, 128.9, 128.6, 127.1, 120.6, 62.3, 46.6, 27.2; IR (Neat) ν_{max} 2902, 1746, 1677, 1478, 1259, 1039, 801, 723 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{17}NNaO_3^+$ $(M+Na)^+$: calcd. 330.1101, found 330.1104.

(*E*)-3-(1-(3-(Methylsulfonyl)phenyl)-2-phenylvinyl)oxazolidin-2-one (3p):

Following the general procedure **GP-2**, compound **3p** (63 mg) was obtained in 92% yield as yellow solid; mp = 178–180 °C; R_f = 0.1 (30% EtOAc/hexane); ^1H NMR (500 MHz, $CDCl_3$) δ 7.87 (dt, J = 8.0, 2.0 Hz, 1H), 7.80 (br t, J = 2.0 Hz, 1H), 7.57 (dt, J = 7.5, 1.5 Hz, 1H), 7.50 (t, J = 8.0 Hz, 1H), 7.14–7.07 (m, 3H), 6.94–6.88 (m, 2H), 6.71 (s, 1H), 4.43 (t, J = 8.0 Hz, 2H), 3.79 (t, J = 8.0 Hz, 2H), 2.88 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 155.6, 140.8, 135.7, 134.7 134.6, 134.5, 129.6, 129.2, 128.7, 128.2, 127.19, 127.16, 122.8, 61.7, 46.1, 44.3, ; IR (Neat) ν_{max} 2919, 1757, 1618, 1482, 1395, 1293, 1099, 746 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{17}NNaO_4S^+$ $(M+Na)^+$: calcd. 366.0770, found 366.0769.

(*E*)-3-(1-(3-Nitrophenyl)-2-phenylvinyl)oxazolidin-2-one (3q):

Following the general procedure **GP-2**, compound **3q** (53 mg) was obtained in 85% yield as yellow solid; mp = 162–164 °C; R_f = 0.3 (30% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 8.20 (ddd, J = 8.5, 1.0, 1.0 Hz, 1H), 8.11 (br t, J = 2.0 Hz, 1H), 7.70 (dt, J = 8.0, 1.5 Hz, 1H), 7.61 (t, J = 8.0 Hz, 1H), 7.18–7.09 (m, 3H), 6.93 (d, J = 8.0 Hz, 2H), 6.69 (s, 1H), 4.43 (t, J = 8.0 Hz, 2H), 3.94 (t, J = 8.0 Hz, 2H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 155.4, 148.3, 136.7, 135.4, 135.3, 130.5, 129.3, 128.7, 127.3, 124.5, 123.7, 120.6, 62.5, 46.7; IR (Neat) ν_{max} 3051, 2165, 1745, 1526,

1346, 1221, 1090, 713 cm^{-1}; **HRMS (ESI)** for $C_{17}H_{14}N_2NaO_4^+$ $(M+Na)^+$: calcd. 333.0846, found 333.0848.

Isopropyl (*E*)-3-(1-(2-oxooxazolidin-3-yl)-2-phenylvinyl)benzoate (3r):

Following the general procedure **GP-2**, compound **3r** (59 mg) was obtained in 84% yield as pale red liquid; R_f = 0.6 (50% EtOAc/hexane);^{1}H NMR (500 MHz, DMSO D_6) δ 7.92 (dt, J = 7.5, 1.5 Hz, 1H), 7.82 (br t, J = 1.5 Hz, 1H), 7.55 (dt, J = 7.5, 1.5 Hz, 1H), 7.49 (t, J = 8.0 Hz, 1H), 7.16–7.07 (m, 3H), 6.90 (d, J = 7.0 Hz, 2H), 6.67 (s, 1H), 5.09 (septet, J = 6.5 Hz, 1H), 4.39 (t, J = 8.0 Hz, 2H), 3.84 (t, J = 8.0 Hz, 2H), 1.27 (d, J = 6.0 Hz, 6H); ^{13}C{^{1}H} NMR (101 MHz, DMSO D_6) δ 165.3, 155.5, 136.3, 135.7, 135.4, 134.5, 130.9, 130.4, 129.53, 129.47, 129.1, 128.6, 127.1, 120.6, 68.8, 62.3, 46.6, 22.0; IR (Neat) ν_{max} 2979, 1749, 1709, 1478, 1395, 1264, 1100, 753 cm^{-1}; **HRMS (ESI)** for $C_{21}H_{21}NNaO_4^+$ $(M+Na)^+$: calcd. 374.1363, found 374.1367.

(*E*)-3-(2-Phenyl-1-(*o*-tolyl)vinyl)oxazolidin-2-one (3s):

Following the general procedure **GP-2**, compound **3s** (49 mg) was obtained in 88% yield as colorless liquid; R_f = 0.7 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.32 (td, J = 7.5, 1.5 Hz, 1H), 7.28 (d, J = 7.5 Hz, 1H), 7.22 (td, J = 7.0, 1.0 Hz, 1H), 7.17 (dd, J = 7.5, 1.0 Hz, 1H), 7.11–7.03 (m, 3H), 6.81–6.77 (m, 2H), 6.73 (s, 1H), 4.32 (t, J = 8.0 Hz, 2H), 3.63 (br s, 2H), 2.14 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.2, 136.8, 136.19, 136.15, 134.6, 130.8, 130.1, 129.3, 128.6, 128.4, 126.9, 126.8, 119.3, 62.0, 45.8, 19.4; IR (Neat) ν_{max} 2914, 1741, 1628, 1393, 1278, 1039, 752 cm^{-1}; **HRMS (ESI)** for $C_{18}H_{17}NNaO_2^+$ $(M+Na)^+$: calcd. 302.1151, found 302.1150.

(*E*)-3-(1-(Naphthalen-1-yl)-2-phenylvinyl)oxazolidin-2-one (3t):

Following the general procedure **GP-2**, compound **3t** (57 mg) was obtained in 90% yield as colorless gummy liquid; R_f = 0.6 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 8.05–7.98 (m, 2H), 7.94–7.89 (m, 1H), 7.59–7.49 (m, 3H), 7.43 (dd, J = 7.0, 1.0 Hz, 1H), 7.00–6.95 (m, 4H), 6.73 (dd, J = 7.5, 4.0 Hz, 2H), 4.32–4.21 (m, 2H), 3.75–3.41 (m, 2H); ^{13}C{^{1}H} NMR (101 MHz, DMSO D_6) δ 155.4, 135.9, 135.2, 133.8, 132.8, 131.8, 129.6, 129.0, 128.6, 128.5, 128.4, 127.4, 126.9, 126.7, 126.1, 124.8, 121.5, 61.9, 45.8; IR (Neat) ν_{max} 3052, 2912, 1740,

1626, 1391, 1106, 1038, 799 cm^{-1}; **HRMS (ESI)** for $C_{21}H_{17}NNaO_2^+$ $(M+Na)^+$: calcd. 338.1151, found 338.1154.

(*E*)-1,1'-((1-(2-Oxooxazolidin-3-yl)ethene-1,2-diyl)bis(4,1-phenylene))bis(ethan-1-one) (4a):

Following the general procedure **GP-2**, compound **4a** (66 mg) was obtained in 94% yield as yellow gummy liquid; R_f = 0.2 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 8.5, 2.0 Hz, 2H), 7.71 (dt, J = 8.5, 2.0 Hz, 2H), 7.45 (dt, J = 8.5, 2.0 Hz, 2H), 7.02 (d, J = 8.5 Hz, 2H), 6.73 (s, 1H), 4.41 (t, J = 8.0 Hz, 2H), 3.87 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H), 2.48 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 197.6, 155.2, 141.0, 139.2, 138.5, 137.2, 135.1, 130.2, 129.3, 128.9, 128.6, 118.9, 62.4, 46.6, 27.2, 27.0; IR (Neat) ν_{max} 2917, 1748, 1674, 1596, 1395, 1264, 1039, 733 cm^{-1}; **HRMS (ESI)** for $C_{21}H_{19}NNaO_4^+$ $(M+Na)^+$: calcd. 372.1206, found 372.1206.

(*E*)-4-(2-(4-Acetylphenyl)-2-(2-oxooxazolidin-3-yl)vinyl)benzonitrile (4b):

Following the general procedure **GP-2**, compound **4b** (62 mg) was obtained in 93% yield as colorless solid; mp = 151–153 °C; R_f = 0.2 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 8.0, 2.0 Hz, 2H), 7.59 (dt, J = 8.5, 2.0 Hz, 2H), 7.44 (dt, J = 8.0, 2.0 Hz, 2H), 7.04 (d, J = 8.5 Hz, 2H), 6.71 (s, 1H), 4.41 (t, J = 8.0 Hz, 2H), 3.87 (t, J = 8.0 Hz, 2H), 2.60 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 155.1, 141.3, 139.4, 138.8, 137.3, 132.5, 130.2, 129.8, 129.0, 119.3, 117.8, 109.1, 62.5, 46.6, 27.2; IR (Neat) ν_{max} 2971, 2220, 1750, 1675, 1506, 1388, 1164, 843, 720 cm^{-1}; **HRMS (ESI)** for $C_{20}H_{16}N_2NaO_3^+$ $(M+Na)^+$: calcd. 355.1053, found 355.1060.

(*E*)-3-(1-(4-Acetylphenyl)-2-(4-methoxyphenyl)vinyl)oxazolidin-2-one (4c):

Following the general procedure **GP-2**, compound **4c** (62 mg) was obtained in 91% yield as yellow liquid; R_f = 0.4 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.93 (dt, J = 8.5, 2.0 Hz, 2H), 7.43 (dt, J = 8.5, 2.0 Hz, 2H), 6.89 (dt, J = 8.5, 3.0 Hz, 2H), 6.73 (dt, J = 8.5, 3.0 Hz, 2H), 6.66 (s, 1H), 4.38 (t, J = 8.0 Hz, 2H), 3.79 (t, J = 8.0 Hz, 2H), 3.68 (s, 3H), 2.59 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 158.7, 155.7, 140.0, 136.8, 134.2, 130.5, 130.1, 128.9, 127.8, 122.0, 114.2, 62.3, 55.5, 46.7, 27.2; IR (Neat) ν_{max} 2910, 1743, 1677, 1510, 1398, 1247,

1028, 825, 756 cm^{-1}; **HRMS (ESI)** for $C_{20}H_{19}NNaO_4^+$ $(M+Na)^+$: calcd. 360.1206, found 360.1204.

(*E*)-3-(1-(4-Acetylphenyl)-2-(4-bromophenyl)vinyl)oxazolidin-2-one (4d):

Following the general procedure **GP-2**, compound **4d** (70 mg) was obtained in 90% yield as colorless liquid; R_f = 0.3 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.93 (dt, J = 8.5, 2.0 Hz, 2H), 7.42 (dt, J = 8.5, 2.0 Hz, 2H), 7.33 (dt, J = 8.5, 2.5 Hz, 2H), 6.86 (d, J = 8.5 Hz, 2H), 6.65 (s, 1H), 4.40 (t, J = 8.0 Hz, 2H), 3.83 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 155.4, 139.3, 137.1, 137.0, 135.2, 131.6, 131.2, 130.2, 128.9, 120.2, 119.4, 62.4, 46.6, 27.2; IR (Neat) ν_{max} 2920, 1752, 1709, 1681, 1397, 1264, 1040, 721 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{16}BrNNaO_3^+$ $(M+Na)^+$: calcd. 408.0206, found 408.0205.

(*E*)-3-(2-(4-Acetylphenyl)-2-(2-oxooxazolidin-3-yl)vinyl)benzonitrile (4e):

Following the general procedure **GP-2**, compound **4e** (57 mg) was obtained in 85% yield as colorless solid; mp = 159–161 °C; R_f = 0.2 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 8.5, 2.0 Hz, 2H), 7.56 (dt, J = 8.0, 1.5 Hz, 1H), 7.43 (dt, J = 8.5, 2.0 Hz, 2H), 7.34 (br t, J = 1.5 Hz, 1H), 7.32 (t, J = 8.0 Hz, 1H), 7.13 (d, J = 8.0 Hz, 1H), 6.70 (s, 1H), 4.41 (t, J = 8.0 Hz, 2H), 3.86 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 155.2, 138.9, 138.6, 137.5, 137.2, 133.6, 132.6, 130.5, 130.3, 129.8, 128.9, 119.0, 117.5, 111.8, 62.4, 46.6, 27.2; IR (Neat) ν_{max} 3056, 2229, 1752, 1710, 1682, 1397, 1265, 1089, 731 cm^{-1}; **HRMS (ESI)** for $C_{20}H_{17}N_2O_3^+$ $(M+H)^+$: calcd. 333.1234, found 333.1239.

(*E*)-3-(1-(4-Acetylphenyl)-2-(3-methoxyphenyl)vinyl)oxazolidin-2-one (4f):

Following the general procedure **GP-2**, compound **4f** (58 mg) was obtained in 86% yield as colorless liquid; R_f = 0.4 (50% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 8.5, 2.0 Hz, 2H), 7.44 (dt, J = 8.5, 2.0 Hz, 2H), 7.06 (t, J = 8.0 Hz, 1H), 6.71–6.65 (m, 2H), 6.53 (br d, J = 8.0 Hz, 1H), 6.45 (br t, J = 2.0 Hz, 1H), 4.39 (t, J = 8.0 Hz, 2H), 3.82 (t, J = 8.0 Hz, 2H), 3.51 (s, 3H), 2.59 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 159.3, 155.4, 139.8, 137.0, 136.9, 136.5, 130.2, 129.7, 128.8, 121.8, 120.8, 114.3, 113.1, 62.4, 55.1, 46.6, 27.2; IR (Neat) ν_{max} 2917, 1750, 1710, 1680, 1398, 1264, 1153, 1039, 731 cm^{-1}; **HRMS (ESI)** for $C_{20}H_{20}NO_4^+$ $(M+H)^+$: calcd. 338.1387, found 338.1388.

(*E*)-3-(1-(4-Acetylphenyl)-2-(3-bromophenyl)vinyl)oxazolidin-2-one (4g):

Following the general procedure **GP-2**, compound **4g** (69 mg) was obtained in 89% yield as colorless solid; mp = 171–173 °C; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.94 (dt, J = 8.5, 2.0 Hz, 2H), 7.43 (dt, J = 8.5, 2.0 Hz, 2H), 7.31–7.27 (m, 1H), 7.11–7.06 (m, 2H), 6.85 (br d, J = 8.0 Hz, 1H), 6.64 (s, 1H), 4.40 (t, J = 8.0 Hz, 2H), 3.85 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 197.9, 155.2, 139.2, 138.5, 137.8, 137.1, 131.8, 130.6, 130.2, 129.7, 128.9, 128.0, 121.9, 118.4, 62.4, 46.6, 27.2; IR (Neat) ν_{max} 2919, 1750, 1679, 1396, 1263, 1089, 721 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{17}BrNO_3^+$ $(M+H)^+$: calcd. 386.0386, found 386.0381.

(*E*)-3-(1-(4-Acetylphenyl)-2-(naphthalen-1-yl)vinyl)oxazolidin-2-one (4h):

Following the general procedure **GP-2**, compound **4h** (64 mg) was obtained in 89% yield as yellow crystalline solid; mp = 178–180 °C; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 8.19 (d, J = 8.0 Hz, 1H), 7.91 (d, J = 7.5 Hz, 1H), 7.78–7.70 (m, 3H), 7.60–7.51 (m, 2H), 7.28 (d, J = 8.5 Hz, 2H), 7.21 (t, J = 7.5 Hz, 2H), 6.94 (d, J = 7.0 Hz, 1H), 4.47 (t, J = 8.0 Hz, 2H), 3.99 (t, J = 8.0 Hz, 2H), 2.49 (s, 3H); ^{13}C{^{1}H} NMR (101 MHz, DMSO D_6) δ 197.6, 155.8, 139.8, 138.1, 136.9, 133.7, 133.2, 132.1, 129.8, 128.8, 128.3, 127.9, 127.8, 126.7, 126.5, 125.7, 125.1, 120.4, 62.5, 46.9, 26.9; IR (Neat) ν_{max} 3054, 1747, 1664, 1391, 1270, 1029, 777 cm^{-1}; **HRMS (ESI)** for $C_{23}H_{19}NNaO_3^+$ $(M+Na)^+$: calcd. 380.1257, found 380.1260.

(*S,E*)-3-(1-(4-Acetylphenyl)-2-phenylvinyl)-5-benzyloxazolidin-2-one (4i):

Following the general procedure **GP-2**, compound **4i** (74 mg) was obtained in 93% yield as colorless liquid; R_f = 0.7 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.91 (dt, J = 8.5, 2.0 Hz, 2H), 7.35 (dt, J = 8.5, 2.0 Hz, 2H), 7.26 (t, J = 7.5 Hz, 2H), 7.23–7.15 (m, 4H), 7.12 (br d, J = 6.5 Hz, 2H), 7.04–6.99 (m, 2H), 6.93 (s, 1H), 4.40–4.33 (m, 1H), 4.21–4.12 (m, 2H), 3.02 (dd, J = 14.0, 4.5 Hz, 1H), 2.86 (dd, J = 14.0, 8.0 Hz, 1H), 2.59 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 197.9, 155.9, 139.4, 137.0, 136.4, 135.5, 133.8, 130.2, 129.8, 129.4, 128.94, 128.91, 128.7, 127.7, 127.2, 126.8, 66.9, 56.6, 38.7, 27.2; IR (Neat) ν_{max} 3054, 1752, 1711, 1682, 1399, 1264, 1097, 731 cm^{-1}; **HRMS (ESI)** for $C_{26}H_{24}NO_3^+$ $(M+H)^+$: calcd. 398.1751, found 398.1755.

1,7,7-Trimethylbicyclo[2.2.1]heptan-2-yl (*E*)-4-(2-(4-acetylphenyl)-2-(2-oxooxazolidin-3-yl)vinyl)benzoate (4j):

Following the general procedure **GP-2**, compound **4j** (82 mg) was obtained in 84% yield as colorless floppy solid; mp = 174–176 °C; R_f = 0.3 (50% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.94 (d, J = 8.5 Hz, 2H), 7.72 (d, J = 8.5 Hz, 2H), 7.44 (d, J = 8.5 Hz, 2H), 7.04 (d, J = 8.5 Hz, 2H), 6.74 (s, 1H), 4.98 (d, J = 9.5 Hz, 1H), 4.41 (t, J = 8.0 Hz, 2H), 3.86 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H), 2.40–2.30 (m, 1H), 2.04–1.96 (m, 1H), 1.78–1.71 (m, 1H), 1.68 (t, J = 4.5 Hz, 1H), 1.38–1.30 (m, 1H), 1.28–1.20 (m, 1H), 1.02 (dd, J = 14.0, 3.5 Hz, 1H), 0.90 (s, 3H), 0.86 (s, 3H), 0.82 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 197.9, 165.9, 155.2, 141.1, 139.1, 138.5, 137.2, 130.2, 129.38, 129.36, 128.9, 128.3, 118,9, 80.1, 62.4, 49.1, 47.9, 46.7, 44.8, 36.8, 28.1, 27.4, 27.2, 20.0, 19.1, 13.9; IR (Neat) ν_{max} 2955, 1757, 1708, 1683, 1398, 1267, 1117, 731 cm^{-1}; **HRMS (ESI)** for $C_{30}H_{34}NO_5^+$ $(M+H)^+$: calcd. 488.2431, found 488.2435.

Gram scale synthesis of (*E*)-3-(1-(4-acetylphenyl)-2-phenylvinyl)oxazolidin-2-one (3a):

To a mixture of ynamide **1a** (562 mg, 3.0 mmol), 4-acetylphenylboronic acid **2a** (738 mg, 4.5 mmol), CuI (29 mg, 5.0 mol%), **L6** (40 mg, 5.0 mol%), Ag_2CO_3 (1.24 g, 4.5 mmol) in an oven-dried 100 mL sealed tube was added CH_2Cl_2 (0.1M). The mixture was stirred at 40 °C for 12 h. The reaction progress was periodically monitored by TLC. After complete consumption of ynamide, the crude residue was filtered through a small pad of Celite and rinsed with CH_2Cl_2 (5×10.0 mL). Excess aryl boronic acid **2a** was removed by washing with 30 mL saturated $NaHCO_3$ solution and the organic layer was extracted using CH_2Cl_2 (3×10.0 mL). The combined organic layer was concentrated and the crude reaction mixture was purified by chromatography on neutral alumina using hexane/ethyl acetate (4:1) as an eluent. The product **3a** (839 mg) was obtained in 91% yield.

Gram scale synthesis of (*E*)-3-(1-(4-Methoxyphenyl)-2-phenylvinyl)oxazolidin-2-one (3f):

To a mixture of ynamide **1a** (562 mg, 3.0 mmol), 4-methoxyphenylboronic acid **2f** (684 mg, 4.5 mmol), CuI (29 mg, 5.0 mol%), **L6** (40 mg, 5.0 mol%), Ag_2CO_3 (1.24 g, 4.5 mmol) in an oven-dried 100 mL sealed tube was added CH_2Cl_2 (0.1M). The mixture was stirred at 40 °C for 12 h. The reaction progress was periodically monitored by TLC. After complete consumption of ynamide, the crude residue was filtered through a small pad of Celite and rinsed with CH_2Cl_2 (5×10.0 mL). Excess aryl boronic acid **2f** was removed by washing with 30 mL saturated $NaHCO_3$ solution and the organic layer was extracted using CH_2Cl_2 (3×10.0 mL). The combined organic layer was concentrated and the crude reaction mixture was purified by chromatography on neutral

alumina using hexane/ethyl acetate (4:1) as an eluent. The product **3f** (780 mg) was obtained in 88% yield.

Synthesis of 1-(4-acetylphenyl)-2-phenylethan-1-one (6):

To a solution of **3a** (61 mg, 0.2 mmol) in toluene (2.0 mL, 0.1M) $AlCl_3$ (30 mol%) was added. The resulting mixture was stirred at 50 ^oC for one day. The reaction progress was monitored by TLC. Upon completion, the crude mixture was concentrated under the reduced pressure. The crude residue was purified using column chromatography on silica gel to afford **6** (41 mg) in 87% yield as colorless solid; mp = 140–142 ^oC; R_f = 0.6 (30% EtOAc/hexane); ^1H NMR (500 MHz, $CDCl_3$) δ 8.07 (dt, J = 8.5, 2.0 Hz, 2H), 8.01 (dt, J = 8.5, 2.0 Hz, 2H), 7.33 (t, J = 7.5 Hz, 2H), 7.28–7.23 (m, 3H), 4.31 (s, 2H), 2.63 (s, 3H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 197.4, 197.1, 140.2, 139.8, 134.0, 129.4, 128.8, 128.5, 127.1, 45.9, 27.0; IR (Neat) ν_{max} 2895, 1677, 1400, 1260, 826 cm^{-1}; **HRMS (ESI)** for $C_{16}H_{14}NaO_2^+$ $(M+Na)^+$: calcd. 261.0886, found 261.0884.

Synthesis of 1-(4-methoxyphenyl)-2-phenylethan-1-one (7):

To a solution of **3f** (59 mg, 0.2 mmol) in toluene (2.0 mL, 0.1M), $AlCl_3$ (30 mol%) was added. The resulting mixture was stirred at 50 ^oC for one day. The reaction progress was monitored by TLC. Upon completion, the crude mixture was concentrated under the reduced pressure. The crude residue was purified using column chromatography on silica gel to afford **7** (38 mg) in 83% yield as colorless liquid; R_f = 0.7 (30% EtOAc/hexane); ^1H NMR (500 MHz, DMSO D_6) δ 8.04 (dt, J = 9.0, 3.0 Hz, 2H), 7.31 (t, J = 7.5 Hz, 2H), 7.27 (d, J = 6.5 Hz, 2H), 7.22 (tt, J = 7.0, 1.5 Hz, 1H), 7.05 (dt, J = 9.0, 3.0 Hz, 2H), 4.31 (s, 2H), 3.84 (s, 3H); $^{13}C\{^1H\}$ NMR (126 MHz, DMSO D_6) δ 196.5, 163.7, 136.0, 131.3, 130.0, 128.8, 126.9, 114.4, 56.0, 44.9; IR (Neat) ν_{max} 2905, 1707, 1393, 1187, 956,b826 cm^{-1}; **HRMS (ESI)** for $C_{15}H_{15}O_2^+$ $(M+H)^+$: calcd. 227.1067, found 227.1068.

Synthesis of (*E*)-3-(2-Phenyl-1-(4-((trimethylsilyl)ethynyl)phenyl)vinyl)oxazolidin-2-one (8):[10]

To a mixture of **3l** (69 mg, 0.2 mmol), $Pd(PPh_3)_2Cl_2$ (4.0 mol%, 5.6 mg), and CuI (6.0 mol%, 2.3 mg) triethylamine (10 equiv) was added. Trimethylsilylacetylene (1.5 equiv, 30 mg) was added dropwise and nitrogen gas was purged. The resulting mixture was stirred at 90 ^oC overnight. The reaction progress was monitored by TLC. Upon completion, the crude mixture was concentrated

under the reduced pressure. The crude residue was purified using column chromatography on neutral alumina to afford **8** (61 mg) in 84% yield as a red liquid; R_f = 0.4 (30% EtOAc/hexane); ^{1}H NMR (400 MHz, DMSO D_6) δ 7.41 (d, J = 8.0 Hz, 2H), 7.27 (d, J = 8.4 Hz, 2H), 7.19–7.07 (m, 3H), 6.93 (d, J = 6.8 Hz, 2H), 6.65 (s, 1H), 4.38 (t, J = 8.4 Hz, 2H), 3.79 (t, J = 8.0 Hz, 2H), 0.24 (s, 9H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 155.6, 136.4, 135.9, 135.6, 132.2, 130.1, 129.2, 128.5, 127.1, 122.8, 121.4, 105.5, 95.8, 62.2, 46.6, 0.32; IR (Neat) ν_{max} 2956, 2156, 1750, 1396, 1248, 839, 755 cm^{-1}; **HRMS (ESI)** for $C_{22}H_{24}NO_2Si^+$ $(M+H)^+$: calcd. 362.1571, found 362.1570.

Synthesis of (*E*)-3-(1-(4'-Acetyl-[1,1'-biphenyl]-4-yl)-2-phenylvinyl)oxazolidin-2-one (9):[11]

To a mixture of **3l** (69 mg, 0.2 mmol), $Pd(OAc)_2$ (10 mol%, 4.5 mg), tris(o-tolyl)phosphine (20 mol%, 12 mg), K_2CO_3 (3.0 equiv, 83 mg), 1,4-dioxane:water (9:1) (0.2M, 1.0 mL) was added. The resulting mixture was reflux overnight. The reaction progress was monitored by TLC. Upon completion, the crude mixture was concentrated under the reduced pressure. The crude residue was purified using column chromatography on neutral alumina to afford **9** (74 mg) in 96% yield as a white solid; mp = 190–192 °C; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 8.05 (d, J = 8.5 Hz, 2H), 7.86 (d, J = 8.5 Hz, 2H), 7.76 (d, J = 8.5 Hz, 2H), 7.40 (d, J = 8.5 Hz, 2H), 7.15 (t, J = 7.5 Hz, 2H), 7.10 (t, J = 7.5 Hz, 1H), 7.00 (d, J = 7.5 Hz, 2H), 6.71 (s, 1H), 4.39 (t, J = 8.0 Hz, 2H), 3.80 (t, J = 8.0 Hz, 2H), 2.61 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 197.9, 155.7, 144.0, 139.1, 136.4, 136.3, 136.0, 134.9, 130.5, 129.4, 129.2, 128.6, 127.5, 127.2, 127.1, 121.1, 62.3, 46.7, 27.2; IR (Neat) ν_{max} 2921, 1729, 1669, 1409, 1267, 1076, 752 cm^{-1}; **HRMS (ESI)** for $C_{25}H_{22}NO_3^+$ $(M+H)^+$: calcd. 384.1594, found 384.1599.

Synthesis of 2-Hydroxy-1-(4-methoxyphenyl)-2-phenylethan-1-one (10):[12]

To a solution of **3f** (59 mg, 0.2 mmol) in THF (0.1M, 2.0 mL), *m*-CPBA (2.0 equiv, 52 mg) was added. The resulting mixture was stirred at room temperature for two hours. The reaction progress was monitored by TLC. Upon completion, the crude mixture was concentrated under the reduced pressure. The crude residue was purified using column chromatography on silica gel to afford **10** (44 mg) in 91% yield as a white solid; mp = 136–138 °C; R_f = 0.7 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 8.02 (dt, J = 9.0, 3.0 Hz, 2H), 8.44 (d, J = 7.5 Hz, 2H), 7.32 (t, J = 7.5 Hz, 2H), 7.26–7.20 (m, 1H), 6.98 (dt, J = 9.0, 3.0 Hz, 2H), 6.05 (d, J = 6.0 Hz, 1H), 5.98 (d, J

= 6.0 Hz, 1H), 3.79 (s, 3H); $^{13}C\{^{1}H\}$ NMR (126 MHz, DMSO D_6) δ 197.9, 163.6, 140.7, 131.8, 128.9, 128.1, 127.6, 114.3, 75.9, 55.9; IR (Neat) ν_{max} 3423, 2932, 1670, 1596, 1252, 1167, 970 cm^{-1}; **HRMS (ESI)** for $C_{15}H_{14}NaO_3^+$ $(M+Na)^+$: calcd. 265.0835, found 265.0840.

Synthesis of (*E*)-3-(1-(4-acetylphenyl)-2-phenylvinyl)oxazolidin-2-one (3a) in presence of water:

To a mixture of **1a** (37 mg, 0.2 mmol), 4-acetylphenylboronic acid **2a** (49 mg, 0.3 mmol), CuI (3.8 mg, 10 mol%), **L6** (5.4 mg, 10 mol%), Ag_2CO_3 (83 mg, 0.3 mmol) and H_2O (10 equiv) in an oven-dried 15 mL sealed tube was added CH_2Cl_2 (2.0 mL, 0.1M). The mixture was stirred at 40 °C for 12 h. The reaction progress was periodically monitored by TLC. After complete consumption of ynamide, the crude residue was filtered through a small pad of Celite and rinsed with CH_2Cl_2 (5×2.0 mL). Excess aryl boronic acid **2a** was removed by washing with 10 mL saturated $NaHCO_3$ solution and the organic layer was extracted using CH_2Cl_2 (3×5.0 mL). The combined organic layers were concentrated and the crude reaction mixture was purified by chromatography on neutral alumina using hexane/ethyl acetate (4:1) as an eluent to isolate the desired product **3a** (48 mg) in 79% yield as colorless solid; mp = 143–145 °C; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (dt, J = 8.5, 2.0 Hz, 2H), 7.39 (dt, J = 8.5, 2.0 Hz, 2H), 7.15–7.07 (m, 3H), 6.98–6.92 (m, 2H), 6.76 (s, 1H), 4.40 (t, J = 8.0 Hz, 2H), 3.71 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H); $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 197.5, 155.9, 139.2, 137.0, 134.9, 134.8, 129.8, 129.2, 129.0, 128.9, 128.7, 128.2, 127.2, 126.0, 123, 61.7, 46.1, 26.7; IR (Neat) ν_{max} 2972, 1754, 1667, 1399, 1293, 1057, 855, 769 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{18}NO_3^+$ $(M+H)^+$: calcd. 308.1281, found 308.1278.

Synthesis of (*E*)-3-(1-(4-acetylphenyl)-2-phenylvinyl-2-d)oxazolidin-2-oneone (3a–D):

To a mixture of ynamide **1a** (37 mg, 0.2 mmol), 4-acetylphenylboronic acid **2a** (49 mg, 0.3 mmol), CuI (3.8 mg, 10 mol%), **L6** (5.4 mg, 10 mol%), Ag_2CO_3 (83 mg, 0.3 mmol) in an oven-dried 15 mL sealed tube was added D_2O (2.0 mL, 0.1M). The mixture was stirred at 40 °C for 12 h. The reaction progress was periodically monitored by TLC. After complete consumption of ynamide, the crude residue was filtered through a small pad of celite and rinsed with CH_2Cl_2 (5×2.0 mL). Excess of aryl boronic acid **2a** was removed by washing with 10 mL saturated $NaHCO_3$ solution and the organic layer was extracted using CH_2Cl_2 (3×5.0 mL). The combined organic layer was

concentrated and the crude reaction mixture was purified by chromatography on neutral alumina using hexane/ethyl acetate (4:1) as an eluent to isolate the desired product **3a**–**D** (30 mg) in 49% yield as yellow gummy solid; R_f = 0.1 (30% EtOAc/hexane); ^{1}H NMR (500 MHz, DMSO D_6) δ 7.92 (dt, J = 8.5, 2.0 Hz, 2H), 7.43 (dt, J = 8.5, 2.0 Hz, 2H), 7.19–7.08 (m, 3H), 6.94 (dt, J = 7.0, 2.0 Hz, 2H), 6.71 (s, 0.12H), 4.39 (t, J = 8.0 Hz, 2H), 3.82 (t, J = 8.0 Hz, 2H), 2.59 (s, 3H); ^{13}C{^{1}H} NMR (126 MHz, DMSO D_6) δ 197.9, 155.5, 139.7, 136.9, 136.1, 135.6, 130.2, 129.2, 128.8, 128.7, 127.3, 62.4, 46.7, 27.2; IR (Neat) ν_{max} 2921, 1739, 1676, 1397, 1263, 1099, 755 cm^{-1}; **HRMS (ESI)** for $C_{19}H_{17}DNO_3^+$ $(M+H)^+$: calcd. 309.1344, found 309.1349.

ASSOCIATED CONTENT

Copies of the ^{1}H NMR, ^{13}C NMR, ^{19}F NMR pdf spectra for respective products.
Crystallographic data in CIF or another electronic format.

AUTHOR INFORMATION

Corresponding Author

Akhila K. Sahoo*; School of Chemistry, University of Hyderabad, Hyderabad-500046, India;
ORCID: 0000-0001-5570-4759; e-mail: akhilchemistry12@gmail.com or akssc@uohyd.ac.in

ACKNOWLEDGMENT

This research was supported by the SERB-India (CRG-2019-1802). We thank University of Hyderabad (UoH; UPE-CAS and PURSE-FIST) for the overall facility. AM thank CSIR for fellowship. We thank Mr. Mahesh Shrichand Rathod for the help in solving the X-ray crystal data. We thank Dr. Shubham Dutta and Mr. Manash Protim Gogoi for helpful discussion.

REFERENCES

1. (a) Dekorver, K. A.; Li, H.; Lohse, A. G.; Hayashi, R. Lu, Z.; Zhang, Y.; Hsung, R. P. Ynamides: A Modern Functional Group for the New Millennium. *Chem. Rev*. **2010**, *110*, 5064. (b) Evano, G.; Coste, A.; Jouvin, K. Ynamides: versatile tools in organic synthesis. *Angew. Chem. Int. Ed*. **2010**, *49*, 2840. (c) Wang, X. N.; Yeom, H. S.; Fang, L. C.; He,

S.; Ma, Z. X.; Kedrowski, B. L.; Hsung, R. P. Ynamides in ring forming transformations. *Acc. Chem. Res*. **2014**, *47*, 560. (d) Evano, G.; Michelet, B.; Zhang, C. The anionic chemistry of ynamides: A review. *Comptes Rendus Chimie*. **2017**, *20*, 648. (e) Zhou, B.; Tan, T. D.; Zhu, X. Q.; Shang, M.; Ye, L. W. Reversal of regioselectivity in ynamide chemistry. *ACS Cat*. **2019**, *9*, 6393. (f) Hu, Y-C., Zhao, Y., Wan, B.; Chen, Q-A. Reactivity of ynamides in catalytic intermolecular annulations. *Chem. Soc. Rev*. **2021**, *50*, 2582.

2. (a) Carbery, D. R. Enamides: valuable organic substrates *Org. Biomol. Chem.* **2008**, *6*, 3455–3460. (b) Matsubara, R.; Kobayashi, S. Enamides and Enecarbamates as Nucleophiles in Stereoselective C–C and C–N Bond-Forming Reactions. *Acc. Chem. Res.* **2008**, *41*, 292–301. (c) Larock, R. C. Comprehensive Organic Transformations: A Guide to Functional Group Preparations; Wiley-VCH: New York, NY, **1999**. (d) M. R. Tracey, R. P. Hsung, J. Antoline, K. C. M. Kurtz, L. Shen, B. W. Slafer, Y. Zhang, In Science of Synthesis, Houbene Weyl Methods of Molecular Transformations, Weinreb, S. M., Ed., Georg Thieme KG: New York, NY, **1999**; Chapter 21.4. (e) Gopalaiah, K.; Kagan, H. B. Use of Nonfunctionalized Enamides and Enecarbamates in Asymmetric Synthesis. *Chem. Rev.* **2011**, *111*, 4599. (f) Xie, J.-H.; Zhu, S.-F.; Zhou, Q.-L. Transition Metal-Catalyzed Enantioselective Hydrogenation of Enamines and Imines. *Chem. Rev*. **2011**, *111*, 1713. (g) Lone, A. M.; Bhat, B. A. Metal free stereoselective synthesis of functionalized enamides. *Org. Biomol. Chem*. **2014**, *12*, 242. (h) Li, X. Q.; Jiang, M. Y.; Zhan, T. Y.; Cao, W. D.; Feng, X. M. Catalytic Asymmetric Three component Hydroacyloxylation/1,4-Conjugate Addition of Ynamides. *Chem. Asian J*. **2020**, *15*, 1953.

3. For selected reports on the access of enamides via functionalization of ynamides, see: (a) Kramer, S.; Odabachian, Y.; Overgaard, J.; Rottlander, M.; Gagosz, F.; Skrydstrup, F. Taking Advantage of the Ambivalent Reactivity of Ynamides in Gold Catalysis: A Rare Case of Alkyne Dimerization**.** *Angew. Chem. Int. Ed*. **2011**, *50*, 5090. (b) Saito, N.; Saito, K.; Shiro, M; Sato, Y. Regio- and Stereoselective Synthesis of 2-Amino-1,3-diene Derivatives by Ruthenium-Catalyzed Coupling of Ynamides and Ethylene. *Org. Lett*. **2011**, *13*, 2718. (c) Dateer, R. B.; Shaibu, B. S.; Liu, R-S. Gold-Catalyzed Intermolecular

[4+2] and [2+2+2] Cycloadditions of Ynamides with Alkenes. *Angew. Chem. Int. Ed*. **2012**, *51*, 113. (d) Rettenmeier, E.; Schuster, A. M.; Rudolph, M.; Rominger, F.; Gade, C. A.; Hashmi, A. S. K. Gold Catalysis: Highly Functionalized Cyclopentadienes Prepared by Intermolecular Cyclization of Ynamides and Propargylic Carboxylates. *Angew. Chem. Int. Ed*. **2013**, *52*, 5880. (e) Nishimura, T.; Takiguchi, Y.; Maeda, Y.; Hayashi, T. Rhodium-Catalyzed Asymmetric Cycloisomerization of 1,6-Ene-ynamides**.** *Adv. Synth. Catal*. **2013**, *355*, 1374. (f) Heffernan, S. J.; Beddoes, J. M.; Mahon, M. F.; Hennessy, A. J.; Carbery, D. R. Gold-catalysed cascade rearrangements of ynamide propargyl esters. *Chem. Commun*. **2013**, *49*, 2314. (g) Kuram, M. R.; Bhanuchandra, M.; Sahoo, A. K. Gold-catalyzed intermolecular hydrophenoxylation of unactivated internal alkynes. *J. Org. Chem*. **2010**, *75*, 7, 2247–2258. (h) Wang, X-N.; Winston-McPherson, G. N.; Walton, M. C.; Zhang, Y.; Hsung, R. P.; DeKorver, K. A. Copper(I)-Catalyzed Nucleophilic Addition of Ynamides to Acyl Chlorides and Activated *N*-Heterocycles**.** *J. Org. Chem*. **2013**, *78*, 6233. (i) Prabagar, B.; Nayak, S.; Mallick, R. K.; Prasad, R.; Sahoo, A. K. Triphenylphosphine promoted regio and stereoselective α-halogenation of ynamides. *Organic Chemistry Frontiers*, **2016**, *3(1)*, 110–115. (j) Mallick, R. K.; Prabagar, B.; Sahoo, A. K. Regioselective Synthesis of 2,4,5-Trisubstituted Oxazoles and Ketene Aminals via Hydroamidation and Iodo-Imidation of Ynamides. *J. Org. Chem*. **2017**, *82*, 10583–10594. (k) Dutta, S.; Yang, S.; Vanjari, R.; Mallick, R. K.; Gandon, V.; Sahoo, A. K. Keteniminium-Driven Umpolung Difunctionalization of Ynamides. *Angew. Chem. Int. Ed*. **2020**, *59*, 10785–10790. (l) Gogoi, M. P.; Vanjari, R.; Prabagar, B.; Yang, S.; Dutta, S.; Mallick, R. K.; Gandon, V.; Sahoo, A. K. Yb(III)-catalysed *syn*-thioallylation of ynamides. *Chem. Commun*. **2021**, *57*, 7521–7524. (m) Vanjari, R.; Dutta, S.; Yang, S.; Gandon, V.; Sahoo, A. K. Palladium-Catalyzed Regioselective Arylalkenylation of Ynamides. *Org. Lett*. **2022**, *24*, 1524–152. (n) Dutta, S.; Sahoo, A. K. Three Component *syn*-1,2-Arylmethylation of Internal Alkynes. *Angew. Chem. Int. Ed.* **2023**, *62*, e2023006.

4. (a) Tschesche, R.; Kaubmann, E. U. In The Alkaloids. Vol. 15; Manske, R. H. F., Holmes, H. L., Eds.; Academic press: New York. **1975**; pp 165. (b) Nakao, Y.; Matsunaga, S.; Fusetani, N. Three more cyclotheonamides, C, D, and E, potent thrombin

inhibitors from the marine sponge Theonella swinhoei. Bioorg. *Med. Chem*. **1995**, *3*, 1115. (c) Courant, T.; Dagousset, G.; Masson, G. Enamide derivatives: versatile building blocks for total synthesis. *Synthesis.* **2015**, *47*, 1799 (d) Hu, L.; Xu, S.; Zhao, Z.; Yang, Y.; Peng, Z.; Yang, M.; Wang, C.; Zhao, J. Ynamides as Racemization-Free Coupling Reagents for Amide and Peptide Synthesis. *J. Am. Chem. Soc*. **2016**, *138*, 13135.

5. Gourdet, B.; Smith, D. L.; Lam, H. W. Rhodium-catalyzed carbometalation of ynamides with organoboron reagents *Tetrahedron* **2010**, *66*, 6026.

6. Yang, Y.; Wang, L.; Zhang, F.; Zhu, G. Preparation of (*Z*)-α,β-Disubstituted Enamides via Palladium-Catalyzed Addition of Boronic Acids to Ynamides. *J. Org. Chem*. **2014**, *79*, 9319.

7. Yang, Y.; Wang, L.; Zhang, J.; Jin, Y.; Zhu, G. *Chem. Commun*. **2014**, *50*, 2347.

8. For Pd-catalyzed hydroarylation of ynamide in water see; Nicola, A. D.; Marsicano, V.; Arcadi, A.; Michelet. V. Room temperature palladium-catalyzed hydroarylation of ynamides in water. *Tetrahedron Letters*, **2020**, *61*, 151725.

9. For selected article on Cu-catalyzed addition of boronic acids to alkynes see; (a) Jiang, X.; Chu, L.; Qing, F-L. Copper-Catalyzed Oxidative Trifluoromethylation of Terminal Alkynes and Aryl Boronic Acids Using (Trifluoromethyl)trimethylsilane. *J. Org. Chem.* **2012**, *77*, 3, 1251–1257. (b) Zhou, Y.; You, W.; Smith, K. B.; Brown, M. K. Copper-Catalyzed Cross-Coupling of Boronic Esters with Aryl Iodides and Application to the Carboboration of Alkynes and Allenes. *Angew. Chem.* **2014**, *126*, 3543–3547. (c) Tang, J-B.; Bian, J-Q.; Zhang, Y-S.; Cheng, Y-F.; Wen, H-T.; Yu, Z-L.; Li, Z-L.; Gu**,** Q-S.; Chen, G-Q.; Liu, X-Y. Copper-Catalyzed *anti*-Selective Radical 1,2-Alkylarylation of Terminal Alkynes. *Org. Lett.* **2022**, *24*, 13, 2536–2540. (d) Tsushima, T.; Tanaka, H.; Nakanishi, K.; Nakamoto, M.; Yoshida, H. Origins of Internal Regioselectivity in Copper-Catalyzed Borylation of Terminal Alkynes. *ACS Catal.* **2021**, *11*, 23, 14381–14387. (e) Wang, H-R.; Huang, E-H.; Luo, C.; Luo, W-F.; Xu, Y.; Qian, P-C.; Zhou, J-M.; Ye, L-W. Copper-catalyzed tandem *cis*-carbometallation/cyclization of imine-ynamides with arylboronic acids. *Chem. Commun.* **2020**, *56*, 4832–4835. (f) Jang, W-J.;

Lee, W-L.; Moon, J-H.; Lee, J-Y.; Yun, J. Copper-Catalyzed trans-Hydroboration of Terminal Aryl Alkynes: Stereodivergent Synthesis of Alkenylboron Compounds. *Org. Lett.* **2016**, *18*, 6, 1390–1393.

10. Sonogashira, K. Development of Pd–Cu catalyzed cross-coupling of terminal acetylenes with sp^2 -carbon halides. *Journal of Organometallic Chemistry*. **2002**, *653*, 46–49.

11. Wu, Y.; Peng, X.; Luo, B.; Wu, F.; Liu, B.; Song, F.; Huang, P.; Wen, S. Palladium catalyzed dual C–H functionalization of indoles with cyclic diaryliodoniums, an approach to ring fused carbazole derivatives. *Org. Biomol. Chem*. **2014**, *12*, 9777.
12. Miyaura, N.; Suzuki, A. Palladium-Catalyzed Cross-Coupling Reactions of Organoboron Compounds. *Chem. Rev*. 1**995**, *95*, 2457–2483.

13. (a) Palmer, R. A.; T. S. Piper. 2, 2'-Bipyridine Complexes. I. Polarized Crystal Spectra of Tris (2, 2'-bipyridine) copper (II), nickel (II), cobalt (II), iron (II), and ruthenium (II). *Inorganic Chemistry* 5.5 (**1966**): 864–878. (b) Surry, D. S.; Buchwald, S. L. Diamine ligands in copper-catalyzed reactions. *Chem. Sci.* **2010**, *1*, 13–31. (c) Ouali, A.; Spindler, J-F.; Jutand, A.; Taillefe, M. Nitrogen Ligands in Copper-Catalyzed Arylation of Phenols: Structure/Activity Relationships and Applications. *Adv. Synth. Catal*. **2007**, *349*, 1906–1916.

14. For carbocupration see this review: Herbert, M. B.; Grubbs, R. H. Copper mediated carbometalation reactions, *Chem. Soc. Rev*. **2016**, *45*, 4552–4566 and references cited therein.

15. For the synthesis of ynamides see: (a) Frederick, M. O.; Mulder, J. A.; Tracey, M. R.; Hsung, R. P.; Huang, J.; Kurtz, K. C.; Shen, L.; Douglas, C. J. A copper-catalyzed C−N bond formation involving sp-hybridized carbons. A direct entry to chiral ynamides via N-alkynylation of amides. *J. Am. Chem. Soc*. **2003,** *125*, 2368. (b) Dunetz, J. R.; Danheiser, R. L. Coppermediated N-alkynylation of carbamates, ureas, and sulfonamides. A general method for the synthesis of ynamides. *Org. Lett*. **2003**, *5*, 4011. (c) Hamada, T.; Ye, X.; Stahl, S. S. Copper catalyzed aerobic oxidative amidation of terminal alkynes: efficient synthesis of ynamides. *J. Am. Chem. Soc*. **2008**, *130*, 833. (d)

Coste, A.; Karthikeyan, G.; Couty, F.; Evano, G. Copper-Mediated Coupling of 1, 1-Dibromo-1-alkenes with Nitrogen Nucleophiles: A General Method for the Synthesis of Ynamides. *Angew. Chem. Int. Ed*. **2009**, *48*, 4381. (e) Jouvin, K.; Couty, F.; Evano, G. Copper-catalyzed alkynylation of amides with potassium alkynyltrifluoroborates: A room-temperature, base-free synthesis of ynamides. *Org. Lett*. **2010**, *12*, 3272.

16. Dutta, S.; Shandilya, S.; Yang, S; Gogoi, M. P.; Gandon, V.; Sahoo, A. K. Cationic-palladium catalyzed regio- and stereoselective syn-1,2-dicarbofunctionalization of unsymmetrical internal alkyne. *Nat. Commun*. **2022**, *13*, 1360.