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Catalytic Synthesis of 5-Fluoro-2-oxazolines: Using BF_3·Et_2O as the Fluorine Source and Activating Reagent

Hongli Chai,‖ Xiang Zhen,‖ Xueqing Wang, Liang Qi, Yuji Qin, Jijun Xue, Zhaoqing Xu,* Hongrui Zhang,* and Weiwei Zhu*

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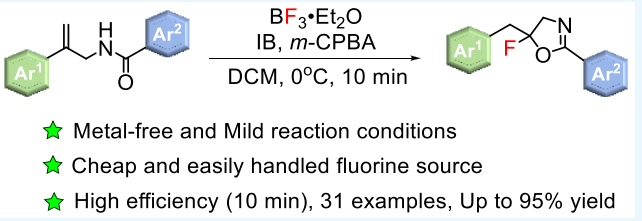
ABSTRACT: Hypervalent iodine catalyst-catalyzed nucleophilic fluorination of unsaturated amides using BF_3·Et_2O as the fluorine source and activating reagent was reported. Various 5-fluoro-2-oxazoline derivatives were synthesized in good to excellent yields (up to 95% isolated yield) within 10 min. The process was efficient and metal-free under mild conditions. A mechanism involving a fluorination/1,2-aryl migration/cyclization cascade was proposed on the basis of previous work and experimental results.

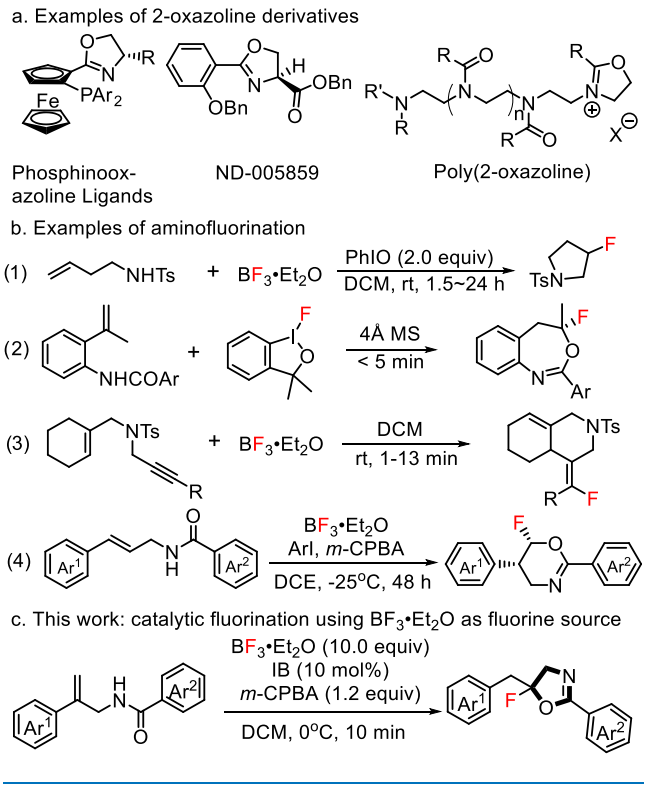


INTRODUCTION

Fluorine plays a significant role in medicinal, agrochemical, and material chemistry due to the unique properties of the F atom.[1] The introduction of F atom(s) into a compound can greatly impact the chemical, physical, and biological properties of the original compound.[1] The fluorinated molecule often displays excellent performance such as higher thermal and metabolic stabilities and weaker intermolecular interactions compared to the primary molecule.[2] However, despite its natural abundance, fluorine-containing natural products are very scarce and there are only a limited number of simple structures that contain fluorine.[3] Thus, the development of efficient strategies to introduce fluorine atom(s) into a molecule is currently one of the most hectic areas of chemistry, as F. Dean Toste wrote, "The current research activity in fluorine chemistry is at an all-time high".[1e]

2-Oxazolines are core scaffolds present in a variety of natural products and bioactive molecule, and derivatives have been found as antifungal,[4] antibacterial,[5] and antituberculosis agents.[6] Besides, 2-oxazolines are widely used in catalytic asymmetric transformations as chiral ligands for different reactions.[7] Moreover, 2-oxazolines are important intermediates in various organic reactions.[8] They can also undergo ring-opening polymerization that allows the preparation of polymer architectures.[9] The application examples of 2-oxazoline derivatives are shown in Scheme 1a.[6,10] Therefore, much attention has been devoted to the development of efficient processes for the synthesis of oxazolines.[11] Undoubtedly, in view of the excellent properties of the fluorinated molecule, an efficient, metal-free, and mild protocol will be welcome for the synthesis of fluorinated oxazolines. During the development of fluorination reactions, the choice of fluorine source is the key issue. The past few decades witnessed the wide applications of fluorine sources such as DAST and its derivatives,[12]

Scheme 1. Examples of 2-Oxazoline Derivatives (a) and Synthesis of Heterocycles via Aminofluorinations (b, c)



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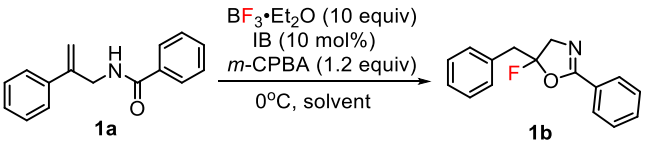
Selectfluor,[13] *N*-fluorobenzenesulfonimide (NFSI),[14] Py·HF,[15] and $Et_3N·3HF$;[16] however, the low atom economy and high cost of the electrophilic fluorine source and the high toxicity of the HF-based nucleophilic fluorine source were issues in the strategies encountered, which set up obstacles for its wide applications. Thus, the development of an efficient fluorination method using a low-cost, low-toxic, and atom-economic fluorine source is our goal. As a versatile, cheap, and easily handled Lewis acid, $BF_3·Et_2O$ could also act as a fluorine source in various fluorination reactions.[17] Among them, aminofluorinations could result in fluorinated *N*-compounds, including useful *N*-heterocycles (Scheme 1b).[18] In view of operational and environmental advantages associated with hypervalent iodine reagent applied in fluorination reactions,[15,19] we recently reported hypervalent iodine-catalyzed fluorinations using $BF_3·Et_2O$ as s fluorine source. Various fluorinated six-membered and seven-membered *N,O*-heterocycles were synthesized through the metal-free strategy.[18e] To further expand the scope of the catalytic fluorination system, herein, we disclosed a catalytic metal-free oxidative fluorination to provide 5-fluoro-2-oxazolines using $BF_3·Et_2O$ as the fluorine reagent and iodobenzene (IB) as a catalyst precursor in the presence of *meta*-chloroperoxybenzoic acid (*m*-CPBA) (Scheme 1c).

RESULTS AND DISCUSSION

The initial investigation was explored by treating the model substrate *N*-(2-phenylallyl)benzamide (**1a**) with 10.0 equiv of Py·HF, 10 mol % of IB, and 1.2 equiv of *m*-CPBA in dichloromethane (DCM) at 0 °C. After 10 min, it was found that the desired fluorinated product **2a** could be obtained in a very low yield (10%, Table 1, entry 1). When Py·HF was replaced by $Et_3N·3HF$ or KF (CsF), no desired product was detected (Table 1, entries 2 and 3). To our delight, when $BF_3·Et_2O$ was used, the desired **2a** was obtained in 83% yield within 10 min and the substrate **1a** was completely converted (Table 1, entry 4). The experimental results indicated that using neither 2 equiv nor 5 equiv of $BF_3·Et_2O$ would result in a lower yield of the fluorinated products (Table 1, entries 5 and 6). Using more than 10 equiv of $BF_3·Et_2O$ did not show better results (Table 1, entry 7). Solvent screening experiments indicated that the desired fluorine product **2a** could not be generated when EtOAc, Et_2O, MeCN, THF, or acetone was employed as the solvent (Table 1, entries 5−12). The employment of 1,2-dichloroethane (DCE), $CHCl_3$, C_6H_5F, C_6H_5Cl, and toluene did not show superior results compared with that in DCM, producing **2a** in moderate to good yields (55−81%, Table 1, entries 13−17). A decrease in temperature would lead to a long transformation time and low yield (Table 1, entry 15). We then obtained the optimal conditions of the catalytic nucleophilic fluorination reaction: the reaction was carried out in DCM (0.05 M) with 10.0 equiv of $BF_3·Et_2O$, 10 mol % of IB, and 1.2 equiv of *m*-CPBA at 0 °C for 10 min. It should be noted that we used an excess amount of $BF_3·Et_2O$ (2.0 equiv of $BF_3·Et_2O$ were needed according to our possible catalytic cycle) in the reactions because the reaction rate is so fast that the substrates were completely converted within 10 min. So, the excess amount of $BF_3·Et_2O$ would avoid the side reactions (such as oxidative rearrangement, oxidative cyclization). Besides, in organocatalyst-catalyzed nucleophilic fluorinations, an excess amount of fluorine source was usually needed to improve the yields of the products.[15a,b]

Table 1. Optimization of the Reaction Conditions[a]



entry	solvent[b]	F⁻ source[c]	yield[d] (%)
1	CH_2Cl_2	Py·HF	10
2	CH_2Cl_2	$Et_3N·3HF$	0
3	CH_2Cl_2	KF or CsF	0
4	CH_2Cl_2	$BF_3·Et_2O$	83
5[e]	CH_2Cl_2	$BF_3·Et_2O$	32
6[f]	CH_2Cl_2	$BF_3·Et_2O$	66
7[g]	CH_2Cl_2	$BF_3·Et_2O$	82
8	EtOAc	$BF_3·Et_2O$	0
9	Et_2O	$BF_3·Et_2O$	0
10	MeCN	$BF_3·Et_2O$	0
11	THF	$BF_3·Et_2O$	0
12	acetone	$BF_3·Et_2O$	0
13	$CHCl_3$	$BF_3·Et_2O$	66
14	$ClCH_2CH_2Cl$	$BF_3·Et_2O$	81
15	C_6H_5F	$BF_3·Et_2O$	72
16	C_6H_5Cl	$BF_3·Et_2O$	73
17	Toluene	$BF_3·Et_2O$	55
18[h]	CH_2Cl_2	$BF_3·Et_2O$	33

[a]The reaction was carried out on a 0.2 mmol scale at 0 °C for 10 min. [b]4.0 mL of solvent was used. [c]10 equiv of F⁻ source was used. [d]Isolated yield. [e]2 equiv of $BF_3·Et_2O$ were used. [f]5 equiv of $BF_3·Et_2O$ were used. [g]20 equiv of $BF_3·Et_2O$ were used. [h]The reaction was carried out at −20 °C.

With the optimal reaction conditions in hand, we then investigated the substrate scope (Figure 1). The reactions were carried out on a 0.2 mmol scale in 4.0 mL of DCM under the optimal conditions and isolated yields are reported. The structure of **8b** was assigned by X-ray crystallography (Figure 1, CCDC: 2067469, see the Supporting Information), and the structure of all other products was assigned by analogy. As shown in Figure 1, variation of the electronic properties of substituents of *N*-(2-phenylallyl)benzamide with different steric parameters were tolerated, affording the desired fluorinated products with moderate to excellent yields (62−95% isolated yields). The *N*-(2-phenylallyl)benzamides with electron-donating group substituents exhibited higher yields than **1a** upon catalytic nucleophilic fluorinations (Figure 1, **2b−5b** vs **1b**), while the electron-withdrawing group-substituted substrates displayed comparatively low yields (Figure 1, **6b−13b** vs **1b**). Especially, the substrates with strong electron-withdrawing groups underwent the process affording the fluorinated products with 62−70% yields (Figure 1, **12b** and **13b**). As for steric hindrance substrates, the corresponding fluorinated products with excellent yields were obtained (Figure 1, 85 and 82% yields for **3b** and **9b**, respectively). Substrates with heterocyclic or naphthyl groups could also be tolerated and gave the corresponding fluorinated products with high yields (Figure 1, **16b−19b**, **30b**, and **31b**). Gram-scale experiment was conducted to evaluate the applicability of our fluorination method using **4a** (Figure 1) as the substrate, and the desired product was obtained in 85% isolated yields. The result suggested that our protocol was promising in future synthetic applications. Moreover, either electron-donating group- or electron-withdrawing group-

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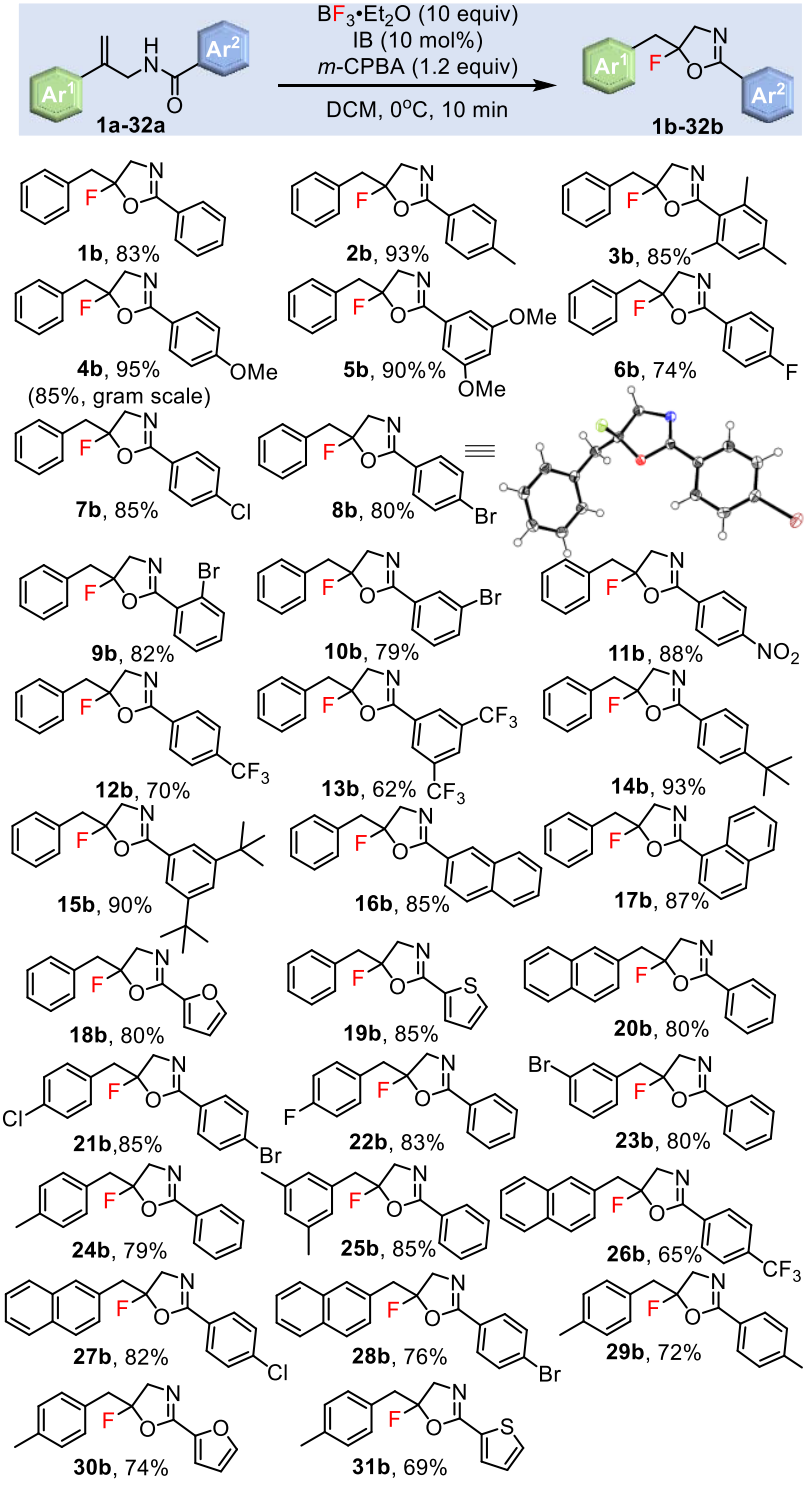

Figure 1. Substrate scope of fluorination reaction using $BF_3{\cdot}Et_2O$ as the fluorine source.

substituted phenyl activated alkenes would also undergo fluorinations, giving the corresponding fluorinated oxazolines in good to excellent yields (Figure 1, **20b**–**31b**).

On the basis of previous work[15a,18a,b,d] and our experimental results, we then proposed the plausible catalytic cycle (as shown in Scheme 2). First, the catalyst precursor IB is oxidized by *m*-CPBA to form Ar–I=O with the formation of *m*-chlorobenzoic acid (*m*-CBA). Then, **IntA** is formed through the activation of Ar–I=O by $BF_3{\cdot}Et_2O$.[20] The electrophilic addition of iodine(III) to the double bond of **Ia** forms **IntB** (anionic $[BF_4]^-$ was released with the assistance of BF_3). The transformation from the hypervalent iodine compound **IntB** to iodonium salt **IntC** is achieved through intermolecular nucleophilic attack of the F^- ($[BF_4]^-$ as the fluorine source) with the simultaneous release of anionic $[BF_3OBF_2]^-$. We initially thought BF_3 could attack the cation **IntB** directly; however, this hypothesis was denied by DFT calculations (DFT calculations carried out in our previous report using a related protocol were considered when proposing a reaction mechanism), which were less favorable in energy.[18e] The bond

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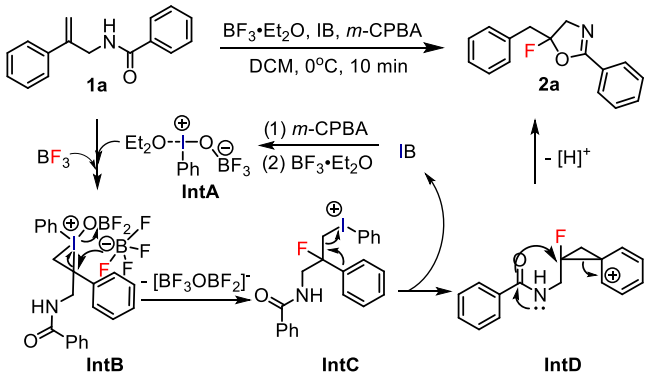
Scheme 2. Proposed Mechanism for the Catalytic Nucleophilic Fluorination Reaction



energy of B−F in BF_3 is higher than that in $[BF_4]^-$; thus, the direct breaking of the B−F bond of BF_3 to release a F^-, which could attack the cation **IntB** directly, is unfavorable under the current reaction conditions. The cyclopropyl compound **IntD** is formed from **IntC** by the displacement of the IB by the nucleophilic attack of the aryl ring.[18b,e] Ring opening of the spirocyclopropyl ring **IntD** takes place intramolecularly via a cyclization with simultaneous ring expansion to the five-membered cation, which formed the oxazoline **1b** with the assistance of anionic $[BF_3OBF_2]^-$. Here, the nucleophilic attack of the amide oxygen takes place regioselectively at the higher-substituted carbon atom of the cyclopropane unit.[18b,e] In addition, Ding and co-workers have proposed a different mechanism for their oxidative arrangement because their process does not have a stoichiometric fluorine nucleophile.[11e] However, combined with our previous DFT calculations[18e] and the reaction process (the hypervalent iodine reagent-mediated fluorinations (5−10 min for our work and Gulder's work) was faster than the oxidative rearrangement (3 h) in ref 11, which might indicate a different conversion process), we thought Gulder's study on the mechanism is more suitable for our reaction.[18b] Besides, if Ar^1 or Ar^2 was changed into aliphatic substituents, the substrates could not undergo the fluorination process to afford the fluorinated products.[18e] This might be because Ar^1 was essential for the formation and stabilization of the "spirocyclopropyl ring" intermediate,[18b] while the Ar^2 contributed to the stabilization of the C═N bond of the products. In a word, the formation of fluorinated 2-oxazoline follows a fluorination/1,2-aryl migration/cyclization cascade.[18b,d]

CONCLUSIONS

In conclusion, we have developed a mild and efficient catalytic nucleophilic fluorination reaction of alkenes to provide 5-fluoro-2-oxazoline derivatives in which a commonly used Lewis acid $BF_3{\cdot}Et_2O$ was employed as the fluorine source with iodobenzene as the catalyst precursor in the presence of *m*-CPBA. The corresponding fluorinated oxazolines with good to excellent yields were obtained within 10 min under the mild and metal-free process. This work expanded the scope of hypervalent iodine-catalyzed fluorinations using $BF_3{\cdot}Et_2O$ as a fluorine source. The studies of the applicability of this catalytic nucleophilic fluorination methodology using other substrates are going on in our group.

EXPERIMENTAL SECTION

General Information. Reagents of analytical grade were purchased from commercial suppliers, and unless otherwise noted, all commercial reagents were used without further purification. Merck F-254 silica gel plates were used for thin-layer analytical chromatography (TLC). Column chromatography purification was carried out using EMD (Merck) Silica Gel 60 (40−63 am). ^1H, ^{13}C, and ^{19}F NMR spectra were recorded with a BRUKER Ascend 400M and a BRUKER Ascend 500 M at 25 °C. The spectra were recorded in $CDCl_3$ as a solvent. Multiplicity was described as follows: b (broad), s (singlet), d (doublet), t (triplet), m (multiplet), dd (doublet of doublets), etc., and coupling constants (*J*) were given in hertz. Chemical shifts are reported in ppm relative to TMS as an internal standard. The peak around delta value of ^1H NMR (7.25) is corresponding to deuterated solvent chloroform, and the peaks around delta value of ^1H NMR (1.56) are corresponding to water contained in the solvent. The peak around the delta value of ^{13}C NMR (76.7−77.4) is referenced to the appropriate NMR solvent residual peaks. High-resolution mass spectrometric data were obtained on an Agilent 6210 time-of-flight HPLC/MS spectrometer (ESI-TOF). Substrates were synthesized according to previous work.[11e]

General Procedures for Catalytic Nucleophilic Aminofluorination. The substrate (0.2 mmol) and iodobenzene (15 mol %) were mixed into the reaction tube, and then DCE (4.0 mL) was added. The mixture was cooled to 0 °C, and after stirring for 5 min at this temperature, *m*-CPBA (1.2 equiv) was added in one portion, followed by the addition of $BF_3{\cdot}Et_2O$ (10.0 equiv) dropwise. After 10 min, the reaction mixture was poured into saturated $NaHCO_3$ (aq), and the organic layer was collected, washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (EtOAc-hexanes (0.5% Et_3N) elution: hexanes/EtOAc (V/V) = 50:1−10:1) to provide the corresponding fluorinated products.

5-Benzyl-5-fluoro-2-phenyl-4,5-dihydrooxazole (***1b***). White solid, R_f: 0.25 (PE/EtOAc (V/V) = 20:1), 42.3 mg, 83% yield. ^1H NMR (400 MHz, $CDCl_3$) δ 7.90−7.88 (m, 2H), 7.44 (t, J = 7.4 Hz, 1H), 7.36 (t, J = 7.4 Hz, 2H), 7.28−7.19 (m, 5H), 4.03−3.84 (m, 2H), 3.39−3.28 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6, 133.6, 132.0, 130.2, 128.7, 128.6, 128.3, 127.5, 126.7, 120.4 (d, J = 234.3 Hz), 63.3 (d, J = 28.4 Hz), 41.7 (d, J = 31.1 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.17. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{16}H_{14}FNO$ $[M + H]^+$: 256.1132; found 256.1130.

5-Benzyl-5-fluoro-2-(p-tolyl)-4,5-dihydrooxazole (***2b***). White solid, R_f: 0.23 (PE/EtOAc (V/V) = 20:1), 50.0 mg, 93% yield. ^1H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, J = 8.2 Hz, 2H), 7.38−7.28 (m, 7H), 4.13−3.93 (m, 2H), 3.49−3.37 (m, 2H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5, 142.4, 133.7, 130.2, 129.2, 128.6, 128.2, 127.4, 124.0, 120.3 (d, J = 233.9 Hz), 63.4 (d, J = 28.2 Hz), 41.7 (d, J = 31.2 Hz), 21.6; ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.22. HRMS (ESI) *m*/*z*: $[M + H]^+$ Calcd for $C_{17}H_{16}FNO$ $[M + H]^+$: 270.1289; found 270.1279.

5-Benzyl-5-fluoro-2-mesityl-4,5-dihydrooxazole (***3b***). White solid, R_f: 0.38 (PE/EtOAc (V/V) = 20:1), 50.5 mg, 85% yield. ^1H NMR (500 MHz, $CDCl_3$) δ 7.25−7.16 (m, 5H), 6.78 (s, 2H), 4.05−3.86 (m, 2H), 3.36−3.25 (m, 2H), 2.20 (s,

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3H), 2.11 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.1, 139.9, 137.4, 133.7, 130.4, 128.6, 128.3, 127.5, 124.9, 120.0 (d, J = 233.3 Hz), 63.1 (d, J = 28.3 Hz), 41.2 (d, J = 31.6 Hz), 21.2, 19.5; ^{19}F NMR (471 MHz, $CDCl_3$) δ −90.95. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{20}FNO$ $[M + H]^+$: 298.1602; found 298.1604.

*5-Benzyl-5-fluoro-2-(4-methoxyphenyl)-4,5-dihydrooxazole (**4b**).* White solid, R_f: 0.13(PE/EtOAc (V/V) = 20:1), 54.2 mg, 95% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, J = 8.8 Hz, 2H), 7.35−7.28 (m, 5H), 6.94 (d, J = 8.8 Hz, 2H), 4.09−3.89 (m, 2H), 3.85 (s, 3H), 3.46−3.34 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5, 162.3, 133.8, 130.2, 130.0, 128.6, 127.4, 120.3 (d, J = 233.7 Hz), 119.2, 113.9, 63.4 (d, J = 28.3 Hz), 55.4, 41.7 (d, J = 31.3 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.30. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}FNO_2$ $[M + H]^+$: 286.1238; found 286.1236.

*5-Benzyl-2-(3,5-dimethoxyphenyl)-5-fluoro-4,5-dihydrooxazole (**5b**).* White solid, R_f: 0.13 (PE/EtOAc (V/V) = 20:1), 50.9 mg, 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35−7.27 (m, 5H), 7.11 (d, J = 2.3 Hz, 2H), 6.60 (t, J = 2.3 Hz, 1H), 4.08−3.92 (m, 2H), 3.83 (s, 6H), 3.46−3.36 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.4, 160.7, 133.6, 130.2, 128.7, 128.5, 127.5, 120.4 (d, J = 234.3 Hz), 105.9, 104.8, 63.3 (d, J = 28.3 Hz), 55.6 (s), 41.6 (d, J = 31.1 Hz); ^{19}F NMR (471 MHz, $CDCl^3$) δ −92.01. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{18}H_{18}FNO$ $[M + H]^+$: 284.1445; found 284.1449.

*5-Benzyl-5-fluoro-2-(4-fluorophenyl)-4,5-dihydrooxazole (**6b**).* White solid, R_f: 0.33 (PE/EtOAc (V/V) = 20:1), 40.4 mg, 74% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (dd, J = 8.7, 5.4 Hz, 2H), 7.27−7.20 (m, 5H), 7.04 (t, J = 8.6 Hz, 2H), 4.01−3.85 (m, 2H), 3.38−3.28 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 165.0 (d, J = 252.8 Hz), 161.6, 133.5, 130.6, 130.2, 128.7, 127.5, 123.0, 120.5 (d, J = 234.5 Hz), 115.8 (d, J = 22.1 Hz), 63.4 (d, J = 28.3 Hz), 41.6 (d, J = 31.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.29, −107.11. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}F_2NO$ $[M + H]^+$: 274.1038; found 274.1035.

*5-Benzyl-2-(4-chlorophenyl)-5-fluoro-4,5-dihydrooxazole (**7b**).* White solid, R_f: 0.28 (PE/EtOAc (V/V) = 20:1), 49.1 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.82 (d, J = 8.5 Hz, 2H), 7.34 (d, J = 8.5 Hz, 2H), 7.27−7.18 (m, 5H), 4.02−3.85 (m, 2H), 3.38−3.28 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.7, 138.3, 133.5, 130.2, 129.6, 128.9, 128.7, 127.6, 125.2, 120.5 (d, J = 235.0 Hz), 63.4 (d, J = 28.2 Hz), 41.6 (d, J = 30.9 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ −92.14. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FNOCl$ $[M + H]^+$: 290.0742; found 290.0737.

*5-Benzyl-2-(4-bromophenyl)-5-fluoro-4,5-dihydrooxazole (**8b**).* White solid, R_f: 0.28 (PE/EtOAc (V/V) = 20:1), 53.4 mg, 80% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 (d, J = 8.5 Hz, 2H), 7.50 (d, J = 8.5 Hz, 2H), 7.27−7.20 (m, 5H), 4.01−3.84 (m, 2H), 3.38−3.28 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 133.4, 131.9, 130.2, 129.8, 128.7, 127.6, 126.8, 125.6, 120.5 (d, J = 235.0 Hz), 63.4 (d, J = 28.3 Hz), 41.6 (d, J = 30.9 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.14. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FNOBr$ $[M + H]^+$: 334.0237, 336.0218; found 334.0232, 336.0215.

*5-Benzyl-2-(2-bromophenyl)-5-fluoro-4,5-dihydrooxazole (**9b**).* White solid, R_f: 0.28 (PE/EtOAc (V/V) = 20:1), 54.6 mg, 82% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 (d, J = 7.7 Hz, 1H), 7.68 (d, J = 7.9 Hz, 1H), 7.39−7.28 (m, 7H), 4.16−3.99 (m, 2H), 3.47−3.37 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.4, 134.3, 133.5, 132.2, 131.6, 130.2, 128.7, 128.2, 127.5, 127.2, 122.0, 120.2 (d, J = 235.2 Hz), 63.6 (d, J = 28.2 Hz), 41.6 (d, J = 30.9 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.44. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FNOBr$ $[M + H]^+$: 334.0237, 336.0218; found 334.0233, 336.0214.

*5-Benzyl-2-(3-bromophenyl)-5-fluoro-4,5-dihydrooxazole (**10b**).* White solid, R_f: 0.33 (PE/EtOAc (V/V) = 20:1), 52.6 mg, 79% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.12 (s, 1H), 7.91 (d, J = 7.8 Hz, 1H), 7.65 (d, J = 8.0 Hz, 1H), 7.36−7.30 (m, 6H), 4.10−3.94 (m, 2H), 3.46−3.36 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.3, 135.0, 133.4, 131.3, 130.2, 130.1, 128.7, 128.5, 127.6, 126.9, 122.6, 120.6 (d, J = 235.5 Hz), 63.2 (d, J = 28.6 Hz), 41.6 (d, J = 30.8 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ −92.11. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FNOBr$ $[M + H]^+$: 334.0237, 336.0218; found 334.0225, 336.0188.

*5-Benzyl-5-fluoro-2-(4-nitrophenyl)-4,5-dihydrooxazole (**11b**).* White solid, R_f: 0.15 (PE/EtOAc (V/V) = 20:1), 52.8 mg, 88% yield. ^{1}H NMR (400 MHz, $CDCl^3$) δ 8.22 (d, J = 8.9 Hz, 2H), 8.06 (d, J = 8.9 Hz, 2H), 7.29−7.19 (m, 5H), 4.09−3.89 (m, 2H), 3.42−3.30 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.7, 149.8, 133.2, 132.4, 130.2, 129.3, 128.8, 127.7, 123.8, 120.8 (d, J = 236.2 Hz), 63.6 (d, J = 28.4 Hz), 41.6 (d, J = 30.7 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.01. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}FN_2O_3$ $[M + H]^+$: 301.0983; found 301.0980.

*5-benzyl-5-fluoro-2-(4-(trifluoromethyl)phenyl)-4,5-dihydrooxazole (**12b**).* White solid, R_f: 0.35 (PE/EtOAc (V/V) = 20:1), 45.2 mg, 70% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (d, J = 8.0 Hz, 2H), 7.63 (d, J = 8.0 Hz, 2H), 7.28−7.18 (m, 5H), 4.05−3.89 (m, 2H), 3.39−3.30 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 133.53 (q, J = 32.6 Hz), 133.32 (s).^{13}C NMR (126 MHz, $CDCl_3$) δ 161.3, 133.53 (q, J = 32.6 Hz), 133.3, 130.2, 130.0, 128.7, 128.7, 127.6, 125.5, 123.7 (q, J = 272.6 Hz), 120.6 (d, J = 235.5 Hz), 63.4 (d, J = 28.3 Hz), 41.6 (d, J = 30.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −63.04 (3F), 92.08 (1F). HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_4NO$ $[M + H]^+$: 324.1006; found 324.1002.

*5-Benzyl-2-(3,5-bis(trifluoromethyl)phenyl)-5-fluoro-4,5-dihydrooxazole (**13b**).* White solid, R_f: 0.58 (PE/EtOAc (V/V) = 20:1), 48.5 mg, 62% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.34 (s, 2H), 7.94 (s, 1H), 7.29−7.23 (m, 5H), 4.07-3.91 (m, 2H), 3.44−3.31 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.9, 133.1, 132.3 (q, J = 34.0 Hz), 130.1, 129.0, 128.8, 128.3, 127.7, 125.3, 122.9 (q, J = 272.8 Hz), 121.0 (d, J = 236.8 Hz), 63.4 (d, J = 28.4 Hz), 41.5 (d, J = 30.4 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ −63.02 (6F), −91.90 (1F). HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C^{18}H^{12}F^7NO$ $[M + H]^+$: 392.0880; found 392.0880.

*5-Benzyl-2-(4-(tert-butyl)phenyl)-5-fluoro-4,5-dihydrooxazole (**14b**).* White solid, R_f: 0.28 (PE/EtOAc (V/V) = 20:1), 57.8 mg, 93% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.82 (d, J = 8.4 Hz, 2H), 7.38 (d, J = 8.4 Hz, 2H), 7.26−7.17 (m, 5H), 4.01−3.84 (m, 2H), 3.37−3.28 (m, 2H), 1.26 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.6, 155.6, 133.7, 130.2, 128.7, 128.1, 127.5, 125.5, 123.8, 120.3 (d, J = 233.9 Hz), 63.2 (d, J = 28.2 Hz), 41.6 (d, J = 31.2 Hz), 35.1, 31.2; ^{19}F NMR (471 MHz, $CDCl_3$) δ −92.03. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{22}FNO$ $[M + H]^+$: 312.1758; found 312.1756.

*5-Benzyl-2-(3,5-di-tert-butylphenyl)-5-fluoro-4,5-dihydrooxazole (**15b**).* White solid, R_f: 0.45 (PE/EtOAc (V/V) = 20:1), 66.1 mg, 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84

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(d, J = 1.8 Hz, 2H), 7.60 (t, J = 1.8 Hz, 1H), 7.36−7.28 (m, 5H), 4.10−3.95 (m, 2H), 3.50−3.37 (m, 2H), 1.36 (s, 18H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.5, 151.3, 133.7, 130.2, 128.7, 127.5, 126.4, 125.8, 122.6, 120.4 (d, J = 234.2 Hz), 63.0 (d, J = 28.3 Hz), 41.7 (d, J = 31.2 Hz), 35.0, 31.4; ^{19}F NMR (471 MHz, $CDCl_3$) δ −91.96. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{24}H_{30}FNO$ $[M + H]^+$: 368.2384; found 368.2383.

*5-Benzyl-5-fluoro-2-(naphthalen-2-yl)-4,5-dihydrooxazole (**16b**).* White solid, R_f: 0.23 (PE/EtOAc (V/V) = 20:1), 51.9 mg, 85% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 1H), 8.03 (d, J = 8.6 Hz, 1H), 7.94 (d, J = 7.3 Hz, 1H), 7.90−7.86 (m, 2H), 7.60-7.53 (m, 2H), 7.38−7.29 (m, 5H), 4.18−3.98 (m, 2H), 3.53−3.41 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6, 135.0, 133.7, 132.6, 130.2, 129.1, 129.0, 128.7, 128.4, 127.9 (2C), 127.5, 126.8, 124.4, 124.1, 120.5 (d, J = 234.2 Hz), 63.5(d, J = 28.2 Hz), 41.7 (d, J = 31.1 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.00. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FNO$ $[M + H]^+$: 306.1289; found 306.1280.

*5-Benzyl-5-fluoro-2-(naphthalen-1-yl)-4,5-dihydrooxazole (**17b**).* White solid, R_f: 0.38 (PE/EtOAc (V/V) = 20:1), 53.1 mg, 87% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.03 (d, J = 8.6 Hz, 1H), 8.06 (d, J = 7.3 Hz, 1H), 7.90 (d, J = 8.2 Hz, 1H), 7.80 (d, J = 7.6 Hz, 1H), 7.54−7.49 (m, 1H), 7.47−7.41 (m, 2H), 7.29−7.19 (m, 5H), 4.20−4.00 (m, 2H), 3.44−3.33 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4, 133.7, 132.7, 131.1, 130.3, 129.6, 128.8, 128.7, 128.6, 127.7, 127.5, 126.4, 126.2, 124.7, 123.1, 119.4 (d, J = 233.5 Hz), 64.0 (d, J = 28.4 Hz), 41.6 (d, J = 31.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.26. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FNO$ $[M + H]^+$: 306.1289; found 306.1282.

*5-Benzyl-5-fluoro-2-(furan-2-yl)-4,5-dihydrooxazole (**18b**).* White solid, R_f: 0.13 (PE/EtOAc (V/V) = 20:1), 39.2 mg, 80% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (s, 1H), 7.27−7.19 (m, 5H), 6.99 (s, 1H), 6.44 (s, 1H), 4.01−3.85 (m, 2H), 3.38−3.26 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.7, 146.0, 141.8, 133.4, 130.2, 128.7, 127.6, 121.4, 119.5, 113.7 (d, J = 491.7 Hz), 63.0 (d, J = 28.1 Hz), 41.5 (d, J = 30.6 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.55. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{12}FNO_2$ $[M + H]^+$: 246.0925; found 246.0929.

*5-Benzyl-5-fluoro-2-(thiophen-2-yl)-4,5-dihydrooxazole (**19b**).* White solid, R_f: 0.20 (PE/EtOAc (V/V) = 20:1), 44.4 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (s, 1H), 7.42 (d, J = 4.7 Hz, 1H), 7.25−7.18 (m, 5H), 7.02 (s, 1H), 3.99−3.84 (m, 2H), 3.38−3.26 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.3, 133.5, 131.2, 130.8, 130.2, 129.1, 128.7, 127.8, 127.6, 120.7 (d, J = 235.7 Hz), 63.3 (d, J = 28.2 Hz), 41.6 (d, J = 30.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.25. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{12}FNOS$ $[M + H]^+$: 262.0696; found 262.0695.

*5-Fluoro-5-(naphthalen-2-yl-methyl)-2-phenyl-4,5-dihydrooxazole (**20b**).* White solid, R_f: 0.45 (PE/EtOAc (V/V) = 20:1), 48.8 mg, 80% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, J = 7.3 Hz, 2H), 7.84−7.81 (m, 3H), 7.77 (s, 1H), 7.53−7.42 (m, 6H), 4.13−3.99 (m, 2H), 3.69−3.53 (m, 2H).^{13}C NMR (125 MHz, $CDCl_3$) δ 161.3, 133.4, 132.6, 131.9, 129.1, 128.5, 128.3, 128.2, 128.0, 127.7(2C), 126.8, 126.2, 126.0, 120.6 (d, J = 235.7 Hz), 63.6 (d, J = 28.2 Hz), 41.8 (d, J = 31.0 Hz).^{19}F NMR (471 MHz, $CDCl_3$) δ −91.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FNO$ $[M + H]^+$: 306.1289; found 306.1289.

*5-(4-Chlorobenzyl)-5-fluoro-2-phenyl-4,5-dihydrooxazole (**21b**).* White solid, R_f: 0.55 (PE/EtOAc (V/V) = 20:1), 49.1 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (d, J = 7.7 Hz, 2H), 7.52 (t, J = 7.3 Hz, 1H), 7.44 (t, J = 7.6 Hz, 2H), 7.31 (d, J = 8.3 Hz, 2H), 7.27−7.25 (m, 2H), 4.12−3.90 (m, 2H), 3.38 (d, J = 14.5 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$) δ 162.4, 133.6, 132.1, 131.9, 131.5, 128.8, 128.6, 128.2, 126.6, 119.9 (d, J = 234.4 Hz), 63.6 (d, J = 28.4 Hz), 41.1 (d, J = 31.6 Hz).^{19}F NMR (471 MHz, $CDCl_3$) δ −92.69. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}ClFNO$ $[M + H]^+$: 290.0742; found 290.0742.

*5-Fluoro-5-(4-fluorobenzyl)-2-phenyl-4,5-dihydrooxazole (**22b**).* White solid, R_f: 0.56 (PE/EtOAc (V/V) = 20:1), 45.3 mg, 83% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, J = 7.4 Hz, 2H), 7.52 (t, J = 7.4 Hz, 1H), 7.44 (t, J = 7.5 Hz, 2H), 7.29 (dd, J = 8.3, 5.5 Hz, 2H), 7.02 (t, J = 8.6 Hz, 2H), 4.12−3.94 (m, 2H), 3.44−3.32 (m, 2H).^{13}C NMR (125 MHz, $CDCl_3$) δ 162.4, 162.3 (d, J = 243.7 Hz), 131.9, 131.8, 128.5, 128.2, 126.7, 126.1, 120.1 (d, J = 233.9 Hz), 115.6, 63.5 (d, J = 28.3 Hz), 40.9 (d, J = 31.5 Hz).^{19}F NMR (376 MHz, $CDCl_3$) δ −92.83 (1F), -115.14 (1F). HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}F_2NO$ $[M + H]^+$: 274.1038; found 274.1044.

*5-(3-Bromobenzyl)-5-fluoro-2-phenyl-4,5-dihydrooxazole (**23b**).* White solid, R_f: 0.50 (PE/EtOAc (V/V) = 20:1), 53.4 mg, 80% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, J = 7.4 Hz, 2H), 7.55−7.50 (m, 2H), 7.46−7.42 (m, 3H), 7.27 (d, J = 7.4 Hz, 1H), 7.21 (t, J = 7.7 Hz, 1H), 4.15−3.91 (m, 2H), 3.37 (m, 2H).^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5, 133.2, 132.0, 130.7, 130.2, 128.6, 128.3, 126.6, 122.6, 119.8 (d, J = 234.5 Hz), 63.6 (d, J = 28.3 Hz), 41.3 (d, J = 31.3 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.62. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}BrFNO$ $[M + H]^+$: 334.0217; found 334.0213.

*5-Fluoro-5-(4-methylbenzyl)-2-phenyl-4,5-dihydrooxazole (**24b**).* White solid, R_f: 0.35 (PE/EtOAc (V/V) = 20:1), 42.5 mg, 79% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, J = 7.3 Hz, 2H), 7.51 (t, J = 7.3 Hz, 1H), 7.46−7.42 (m, 2H), 7.21 (d, J = 7.9 Hz, 2H), 7.14 (d, J = 7.9 Hz, 2H), 4.10−3.91 (m, 2H), 3.43−3.31 (m, 2H), 2.33 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4, 137.1, 131.8, 130.1, 129.4, 128.5, 128.2, 126.9, 126.1, 120.5 (d, J = 233.9 Hz), 63.4 (d, J = 28.2 Hz), 41.2 (d, J = 31.1 Hz), 21.1. ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.20. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}FNO$ $[M + H]^+$: 270.1300; found 270.1289.

*5-(3,5-Dimethylbenzyl)-5-fluoro-2-phenyl-4,5-dihydrooxazole (**25b**).* White solid, R_f: 0.34 (PE/EtOAc (V/V) = 20:1), 48.1 mg, 85% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, J = 8.0 Hz, 2H), 7.54 (t, J = 8.0 Hz, 1H), 7.47 (t, J = 8.0 Hz, 2H), 6.96 (s, 2H), 6.93 (s, 1H), 4.09−3.95 (m, 2H), 3.44−3.29 (m, 2H), 2.30 (s, 6H).^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4, 138.1, 133.4, 131.8, 129.1, 128.5, 128.2, 128.0, 126.9, 120.5 (d, J = 234.2 Hz), 63.4 (d, J = 28.2 Hz), 41.6 (d, J = 31.0 Hz), 21.3.^{19}F NMR (376 MHz, $CDCl_3$) δ −92.24. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{18}H_{18}FNO$ $[M + H]^+$: 284.1452; found 284.1445.

*5-Fluoro-5-(naphthalen-2-yl-methyl)-2-(4-(trifluoromethyl)phenyl)-4,5-dihydrooxazole (**26b**).* White solid, R_f: 0.30 (PE/EtOAc (V/V) = 20:1), 48.5 mg, 65% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (d, J = 8.4 Hz, 2H), 7.87−7.83 (m, 3H), 7.79 (s, 1H), 7.73 (d, J = 8.4 Hz, 2H), 7.52−7.46 (m, 3H), 4.16−4.07 (m, 2H), 3.62 (dd, J = 14.5, 5.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 133.4, 132.6, 130.9, 129.2, 128.6, 128.4, 127.9, 127.7(2C), 126.3, 126.1,

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125.5 (q, J = 4.0 Hz), 120.7 (d, J = 235.7 Hz), 63.6 (d, J = 28.2 Hz), 41.8 (d, J = 31.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −91.71 (1F), −63.06 (3F). HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}F_4NO$ $[M + H]^+$: 374.1122; found 374.1127.

*2-(4-Chlorophenyl)-5-fluoro-5-(naphthalen-2-yl-methyl)-4,5-dihydrooxazole (**27b**).* White solid, R_f: 0.25 (PE/EtOAc (V/V) = 20:1), 55.6 mg, 82% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, J = 8.5 Hz, 2H), 7.81 (d, J = 8.0 Hz, 2H), 7.76 (s, 1H), 7.48 (t, J = 8.0 Hz, 2H), 7.44 (d, J = 8.5 Hz, 1H), 7.41 (d, J = 8.0 Hz, 2H), 4.08-4.01 (m, 2H), 3.62 (dd, J = 14.6, 7.6 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.5, 138.2, 133.4, 132.6, 131.0, 129.6, 129.1, 128.9, 128.3, 128.0, 127.7 (2C), 126.3, 126.1, 125.3, 120.6 (d, J = 233.7 Hz), 63.6 (d, J = 27.5 Hz), 41.8 (d, J = 31.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −91.83. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{15}ClFNO$ $[M + H]^+$: 340.0862; found 340.0875.

*2-(4-Bromophenyl)-5-fluoro-5-(naphthalen-2-yl-methyl)-4,5-dihydrooxazole (**28b**).* White solid, R_f: 0.25 (PE/EtOAc (V/V) = 20:1), 58.4 mg, 76% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83−7.80 (m, 5H), 7.76 (s, 1H), 7.57 (d, J = 8.5 Hz, 2H), 7.48 (t, J = 8.0 Hz, 2H),7.44 (d, J = 8.5 Hz, 1H), 4.07−4.00 (m, 2H), 3.62 (dd, J = 14.6, 7.6 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.6, 133.4, 132.6, 131.8, 131.0, 129.7, 129.1, 128.3, 128.0, 127.7(2C), 126.7, 126.3, 126.1, 125.7, 120.6 (d, J = 233.8 Hz), 63.6 (d, J = 27.5 Hz), 41.8 (d, J = 31.6 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ −91.79. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{15}BrFNO$ $[M + H]^+$: 384.0371; found 384.0370.

*5-Fluoro-5-(4-methylbenzyl)-2-(p-tolyl)-4,5-dihydrooxazole (**29b**).* White solid, R_f: 0.25 (PE/EtOAc (V/V) = 20:1), 40.8 mg, 72% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, J = 8.0 Hz, 2H), 7.24−7.19 (m, 4H), 7.12 (d, J = 8.0 Hz, 2H), 4.01−3.89 (m, 2H), 3.42−3.30 (m, 2H), 2.40 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5, 142.3, 137.1, 130.6, 130.0, 129.3, 129.2, 128.2, 124.0, 120.6 (d, J = 233.8 Hz), 63.3 (d, J = 28.3 Hz), 41.2 (d, J = 31.4 Hz), 21.6, 21.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.32. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{18}H_{18}FNO$ $[M + H]^+$: 284.1453; found 284.1445.

*5-Fluoro-2-(furan-2-yl)-5-(4-methylbenzyl)-4,5-dihydrooxazole (**30b**).* White solid, 38.5 mg, 74% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, J = 3.4 Hz, 1H), 7.18 (d, J = 8.0 Hz, 2H), 7.12 (d, J = 8.0 Hz, 2H), 7.03 (d, J = 3.4 Hz, 1H), 6.51 (dd, J = 3.5 Hz, 1H), 4.03−3.89 (m, 2H), 3.41−3.27 (m, 2H), 2.32 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 154.7, 145.9, 141.9, 137.2, 130.3, 130.0, 129.4, 120.6 (d, J = 233.8 Hz), 115.4, 111.7, 63.1 (d, J = 28.2 Hz), 41.0 (d, J = 30.6 Hz), 21.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ −92.64. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}FNO_2$ $[M + H]^+$: 260.1093; found 260.1081.

*5-Fluoro-5-(4-methylbenzyl)-2-(thiophen-2-yl)-4,5-dihydrooxazole (**31b**).* White solid, 38.1 mg, 69% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, J = 3.4 Hz, 1H), 7.48 (d, J = 3.4 Hz, 1H), 7.19 (d, J = 8.0 Hz, 2H), 7.12 (d, J = 8.0 Hz, 2H), 7.09 (dd, J = 3.4 Hz, 1H), 4.01−3.90 (m, 2H), 3.40−3.29 (m, 2H), 2.32 (s, 3H); δ ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.2, 137.2, 131.0, 130.5, 130.4, 130.0, 129.4, 127.7, 120.6 (d, J = 233.5 Hz), 63.3 (d, J = 30.9 Hz), 41.1 (d, J = 30.9 Hz), 21.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ −92.35. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}FNOS$ $[M + H]^+$: 276.0861; found 276.0853.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acsomega.2c01791.

Experimental details; characterization of new compounds; and copies of ^{1}H,^{13}C, ^{19}F NMR, and HRMS spectra(PDF)

Crystallgraphic data (CIF)

■ AUTHOR INFORMATION

Corresponding Authors

Zhaoqing Xu − *Key Laboratory of Preclinical Study for New Drugs of Gansu Province, School of Basic Medical Science, Lanzhou University, Lanzhou 730000, China;* orcid.org/0000-0001-7663-6249; Email: zqxu@lzu.edu.cn

Hongrui Zhang − *Key Laboratory of Preclinical Study for New Drugs of Gansu Province, School of Basic Medical Science, Lanzhou University, Lanzhou 730000, China;* Email: zhanghr@lzu.edu.cn

Weiwei Zhu − *School of Pharmaceutical Sciences, Sun Yat-Sen University, Guangzhou 510006, China;* orcid.org/0000-0002-1448-7708; Email: zhuww8@sysu.edu.cn

Authors

Hongli Chai − *Key Laboratory of Preclinical Study for New Drugs of Gansu Province, School of Basic Medical Science, Lanzhou University, Lanzhou 730000, China*

Xiang Zhen − *Key Laboratory of Preclinical Study for New Drugs of Gansu Province, School of Basic Medical Science, Lanzhou University, Lanzhou 730000, China*

Xueqing Wang − *Department of Pharmacy, College of Life Sciences, China Jiliang University, Hangzhou 310018, China*

Liang Qi − *Department of Pharmacy, College of Life Sciences, China Jiliang University, Hangzhou 310018, China*

Yuji Qin − *School of Pharmaceutical Sciences, Sun Yat-Sen University, Guangzhou 510006, China*

Jijun Xue − *Key Laboratory of Preclinical Study for New Drugs of Gansu Province, School of Basic Medical Science, Lanzhou University, Lanzhou 730000, China*

Complete contact information is available at: https://pubs.acs.org/10.1021/acsomega.2c01791

Author Contributions

‖H.C. and X.Z. contributed equally.

Notes

The authors declare no competing financial interest.

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