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Concise Asymmetric Synthesis of β-Trifluoromethylated α,β-Diamino Esters through Addition Reactions of Glycine Esters to CF_3-Sulfinylimine

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(*S*)-*N*-(*tert*-Butylsulfinyl)-3,3,3-trifluoroacetaldimine underwent reactions with enolates of glycine esters with quite remarkable stereochemical results, that is, with virtually complete (>99 % *de*) diastereoselectivity and excellent (>98 %) yields. Furthermore, the reactions are conducted under operationally convenient conditions (Cs_2CO_3-catalyzed, ambient temperature) to provide the most advanced, general, and scalable access to biologically important β-trifluoromethylated α,β-diamino acids.

Introduction

α,β-Diamino acids and their derivatives comprise a biologically potent class of naturally occurring amino acids and have been the focus of multidisciplinary research for quite some time.[1] Besides their specific biological roles, α,β-diamino acids that contain two adjacent stereogenic centers and functional groups serve as key structural intermediates in the pharmaceutical industry and the health sciences.[2] However, the preparation of amino acids that contain two vicinal amino groups is synthetically rather challenging[3–5] in comparison to the synthesis of regular α-amino acids[6] or even α-amino-β-hydroxy acids.[7] One of the most straightforward and generalized approaches to α,β-diamino acids is through Mannich addition reactions between properly protected glycine-derived enolates and imines.[8]

Our interest in the area of biologically important, tailor-made[9] amines and amino acids is related to the asymmetric synthesis of the corresponding fluorinated derivatives.[10] Thus, the substitution of hydrogen with fluorine is currently an established strategy to develop new drugs with improved metabolic stability, bioavailability, and protein–ligand interactions.[11,12] In particular, the CF_3–$CH(NH_2)$– structural feature is generally used as a pharmacophore in the design of bioactive compounds, which include α- and β-amino acids.[13] Considering that naturally occurring diaminobutanoic acid has been shown to play a critical role in the biological activity of various peptide antibiotics, it may be particularly interesting to study its derivatives, such as its fluorinated analogue 2,3-diamino-4,4,4-trifluorobutanoic acid.[14] However, access to enantiomerically pure samples of 2,3-diamino-4,4,4-trifluorobutanoic acid is rather limited, as only two literature approaches have been developed to date. One is the Mannich addition reaction of a chiral Ni^{II} complex of a glycine Schiff base with *N*-(*p*-methoxyphenyl)-protected imines, whereas the second involves the silver-catalyzed 1,3-dipolar cycloaddition of azomethine ylides with a fluorinated imine.[15] Both approaches share the drawback of an incomplete stereochemical outcome, which necessitates tedious chromatographic purifications and, therefore, renders these methods of limited value for relatively large-scale synthesis. Herein, we report the addition reactions between (*S*)-*N*-*tert*-butylsulfinyl-3,3,3-trifluoroacetaldimine (**1**) and glycine-derived enolates as the most advanced, convenient, and scalable approach to prepare of β-trifluoromethylated α,β-diamino acids (see Scheme 1). The reactions were conducted under operationally convenient conditions at ambient temperature to give the target products with a remarkable stereochemical outcome (>99 %*de*, >98 % yield; see Scheme 1). Although the reaction of glycine esters with a chiral CF_3-sulfinylimine has been reported by Dolbier,[16] the reactions reported in the patent were conducted at –78 °C in the presence of lithium hexamethyldisilazide (LiHMDS) and gave a mixture of diastereomers in only 17 % chemical yield. Furthermore, the ratio of the diastereomers, the absolute configuration, and the mechanism were not discussed or reasonably proved.

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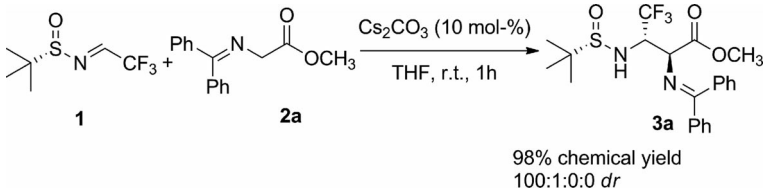


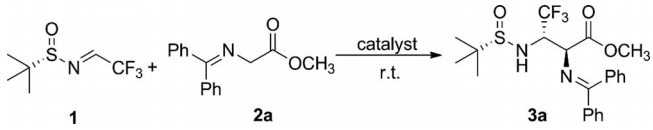
Scheme 1. Cs_2CO_3-catalyzed direct addition of imine **1** (THF = tetrahydrofuran).

Results and Discussion

Our experience with the asymmetric synthesis of various biologically relevant compounds[17] provided us with an appreciation for the synthetic value of *N*-sulfinamides as uniquely potent, versatile, and convenient chiral auxiliaries.[8] In particular, (S_S)-(*N*-*tert*-butylsulfinyl)-3,3,3-trifluoroacetaldimine (**1**) demonstrates exceptionally high CF_3-induced reactivity and stereocontrol. Furthermore, the commercial availability of imine **1** on a kilogram scale in both enantiomeric forms[18] has stimulated vigorous research activity in the application of this reagent to prepare biologically important 2,2,2-trifluoroethylamino-containing compounds.[18,19] However, all previously reported reactions of imine **1** have required the use of an anhydrous solvent, low temperatures (–78 °C), and strong bases, such as lithium diisopropylamide (LDA), *n*BuLi, and LiHMDS. These operationally inconvenient conditions present an obvious drawback to the application of these procedures. The study of reactions between **1** and glycine-derived enolates had an additional impetus, however, as we expected that the high C–H acidity of the latter would allow the reactions to be conducted under operationally convenient conditions[20] and lead to the development of a truly useful synthetic method.

At the outset of this study, we selected glycine methyl ester **2a** as a model substrate to optimize the reaction conditions (see Table 1). We were delighted to observe that glycine Schiff base **2a** underwent a reaction with sulfinylimine **1** at ambient temperature in the absence of a base catalyst. However, this addition reaction proceeded at quite a slow rate, requiring 48 h to reach completion. The desired product **3a** was isolated in 43% yield with a reasonably good diastereoselectivity (isomer ratio of 100:18:0:0 as determined by ^{19}F NMR analysis; see Table 1, Entry 1). With these results, we planned a systematic study of the reaction conditions to achieve a quantitative stereochemical outcome. We found that potassium *tert*-butoxide and lithium *tert*-butoxide were very effective at catalyzing the addition

Table 1. Optimization of reaction conditions.[a]



Entry	Catalyst [mol-%]	Solvent	Time [h]	Yield [%][b]	Isomer ratio[c]
1	no catalyst	DCM[d]	48	43	100:18:0:0
2	*t*BuOK (20)	DCM	1	77	100:9:0:0
3	*t*BuOLi (20)	DCM	1	78	100:7:0:0
4	CH_3ONa (20)	DCM	24	52	100:5:0:39
5	PhONa (20)	DCM	1	88	100:10:0:1
6	NaOH (20)	DCM	1	90	100:14:9:1
7	K_2CO_3 (20)	DCM	24	85	100:12:0:1
8	Cs_2CO_3 (20)	DCM	1	95	100:7:0:0
9	TMG[d] (20)	DCM	1	93	100:7:0:1
10	DABCO[d] (20)	DCM	24	77	100:13:0:1
11	Et_3N (20)	DCM	48	46	100:18:0:1
12	DMAP[d] (20)	DCM	24	41	100:15:0:0
13	DBU[d] (20)	DCM	1	89	100:11:0:0
14	Cs_2CO_3 (20)	$CHCl_3$	1	95	100:4:0:0
15	Cs_2CO_3 (20)	THF	1	97	100:1:0:0
16	Cs_2CO_3 (20)	DMF	1	87	100:5:0:0
17	Cs_2CO_3 (20)	CH_3CN	1	91	100:9:0:0
18	Cs_2CO_3 (20)	toluene	1	91	100: 8:0:0
19	Cs_2CO_3 (20)	hexane	1	85	100:76:10:15
20	Cs_2CO_3 (20)	CH_3OH	12	<20	–
21	Cs_2CO_3 (10)	THF	1	98	100:1:0:0
22	Cs_2CO_3 (5)	THF	12	92	100:3:0:0

[a] Reagents and conditions: sulfinylimine **1** (1.0 mmol), methyl 2-[(diphenylmethylene)amino]acetate (**2a**; 1.1 mmol), solvent (5 mL). [b] Isolated yields. [c] Determined by ^{19}F NMR analysis. [d] DCM = dichloromethane, TMG = *N*,*N*,*N*′,*N*′-tetramethylguanidine, DABCO = 1,4-diazabicyclo[2.2.2]octane, DMAP = 4-(dimethylamino)pyridine, DBU = 1,8-diazabicyclo[5.4.0]undec-7-ene.

reaction (room temp., 1 h) and dramatically increased the yields and diastereoselectivities of the products (see Table 1, Entries 2 and 3). Several common inorganic and organic bases were further examined as catalysts. Inorganic bases were found to be more efficient (see Table 1, Entries 4–8) and gave both higher chemical yields and diastereoselectivities in comparison to the reactions catalyzed by organic bases (see Table 1, Entries 9–13). Among the inorganic bases, Cs_2CO_3 gave the best results in terms of reactivity and stereoselectivity (see Table 1, Entry 8) to provide the target product **3a** in the highest yield and with the highest diastereoselectivity (95% yield, 100:7:0:0 *dr*). Next, the optimization of the reaction conditions with Cs_2CO_3 as the catalyst was the focus, and this was achieved by screening for the appropriate solvent (see Table 1, Entries 14–20). Using $CHCl_3$, THF, or *N*,*N*-dimethylformamide (DMF) as the solvent improved the diastereoselectivity (see Table 1, Entries 14–16), and THF provided the best results. Further optimization efforts showed that the catalyst loading could be lowered to 10 mol-% without any noticeable drop in both the yield and diastereoselectivity (see Table 1, Entries 21 and 22).

With the optimized conditions in hand, we then studied the effect of the glycine ester moiety on the stereochemical outcome of this reaction (see Table 2). Almost all of the tested glycine ester substrates worked well under the optimized conditions to afford the corresponding addition products in both excellent yields and with excellent diastereoselectivities. In the case of the aliphatic glycine esters, the results indicate that the outcome of the addition was dependent on the alkyl moiety. The yield and diastereoselectivity of the product decreased slightly as the steric bulk of the alkyl group increased (see Table 2, Entries 1–6). In contrast, in the case of the aromatic glycine esters, the electronic and steric features of the aromatic ring showed almost no appreciable effect on the yield and diastereoselectivity of the product (100:1:0:0 *dr* for all of these substrates; see Table 2, Entries 7–17). Notably, the aromatic glycine esters that contained a 1-naphthyl or 2-naphthyl ring (see Table 2, Entries 18 and19) also performed well in this reaction to give the target products in excellent yields (92 and 91%, respectively) and with only slightly lower diastereoselectivities (100:5:0:0).

To assign the absolute configuration of the two newly created stereogenic centers, we performed a crystal structure analysis of **3a** (see Figure 1). As revealed by the X-ray study, product **3a** has the (2*S*,3*S*) configuration. The absolute configurations of other products were assigned as (2*S*,3*S*) on the basis of the similarities of their spectroscopic and chiroptical properties.

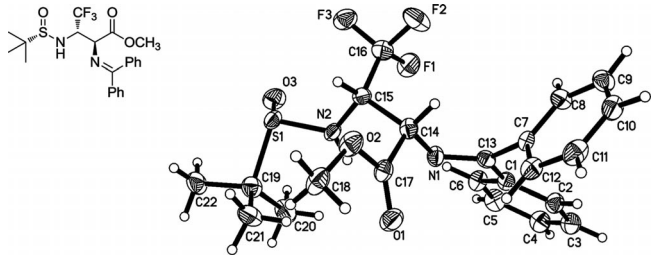
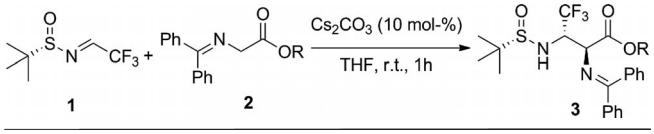


Figure 1. ORTEP diagram of compound **3a**.

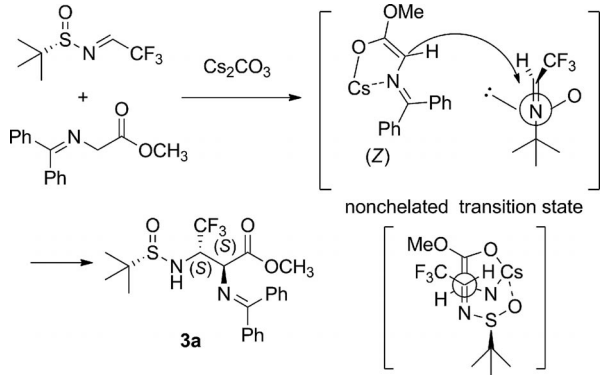
Table 2. Reaction scope of glycine ester derivatives.[a]



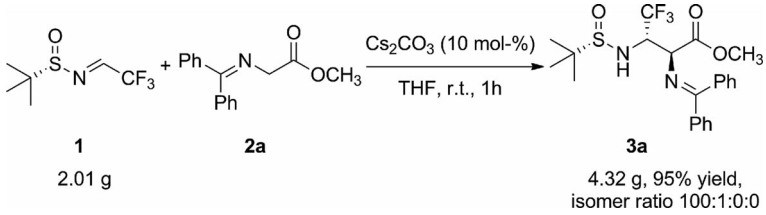
Entry	R	Product	Yield [%][b]	Isomer ratio[c]
1	Me	**3a**	98	100:1:0:0
2	Et	**3b**	97	100:1:0:0
3	*n*Pr	**3c**	97	100:1:0:0
4	*i*Pr	**3d**	94	100:4:0:0
5	*t*Bu	**3e**	94	100:5:0:0
6	Bn	**3f**	95	100:4:0:0
7	C_6H_5	**3g**	97	100:1:0:0
8	2-ClC_6H_4	**3h**	93	100:1:0:0
9	3-ClC_6H_4	**3i**	94	100:1:0:0
10	4-ClC_6H_4	**3j**	95	100:1:0:0
11	4-BrC_6H_4	**3k**	98	100:1:0:0
12	4-FC_6H_4	**3l**	97	100:1:0:0
13	2-MeC_6H_4	**3m**	93	100:1:0:0
14	3-MeC_6H_4	**3n**	92	100:1:0:0
15	4-MeC_6H_4	**3o**	89	100:1:0:0
16	4-$MeOC_6H_4$	**3p**	93	100:1:0:0
17	2,6-$Cl_2C_6H_3$	**3q**	89	100:1:0:0
18	1-naphthyl	**3r**	92	100:5:0:0
19	2-naphthyl	**3s**	91	100:5:0:0

[a] Reagents and conditions: sulfinylimine **1** (1.0 mmol), glycine esters **2** (1.1 mmol), THF (5 mL). [b] Isolated yields. [c] Determined by ^{19}F NMR analysis.

To account for the observed preference of the products **3** to have the (2*S*,3*S*) absolute configuration, we propose that the studied reactions proceed through an open nonchelated transition state (see Scheme 2). Although the nonchelated transition state model has been discussed in the literature,[21] the observed, virtually complete level of stereocontrol requires some additional considerations. We believe that the geometric homogeneity of the glycine enolate might also play a significant role.[22,23] As shown by the Newman projection in Scheme 2, besides the intramolecular chela-



Scheme 2. Proposed mechanism for the asymmetric addition that includes a nonchelated transition state and its Newman projection.



Scheme 3. Large-scale application of the reaction.

tion of the Cs atom by the enolate, some possible coordination of the S–O oxygen to the Cs atom may lead to the additional stabilization of the transition state to give the (2*S*,3*S*)-configured products **3**.

The reactions under study have also been explored in terms of their scalability to a gram-scale synthesis. Gratifyingly, an excellent yield (95%) and perfect diastereoselectivity (isomer ratio of 100:1:0:0) were obtained, as the loading amount of sulfinylimine **1** was increased from 0.20 to 2.01 g (see Scheme 3). To our delight, there was practically no decrease in the yield or diastereoselectivity in comparison to the 0.20 g scale reaction. This result underscores the preparative potential of this method for the large-scale preparation of chiral β-trifluoromethylated α,β-diamino esters, which are needed in large quantities for the systematic study of their biological properties.

Finally, considering that these target amino acids might be useful blocks for peptide synthesis, we briefly studied the possible selective deprotection of compound **3e**. As shown in Scheme 4, the treatment of **3e** with low-concentrated trifluoroacetic acid (TFA) in DCM followed by neutralization with triethylamine (TEA) allowed for the highly chemoselective deprotection of the labile Schiff base function. The resulting free amine **4e** was isolated in good (93%) yield.

Scheme 4. Selective deprotection of functional group.

Conclusions

We have developed a truly practical method to synthesize a variety of β-trifluoromethylated α,β-diamino esters in both excellent yields and diastereoselectivities. The reaction procedure is operationally very simple and requires only mixing of the reagents and stirring at room temperature for 1 h. Importantly, this protocol proved to be scalable without compromising the stereochemical outcome. Further applications of imine **1** to the preparation of other chiral fluorinated amino compounds are under investigation and will be reported at a later date.

Experimental Section

General Methods: All reagents were obtained from commercial suppliers and used without further purification. The reactions were conducted in a closed system under air and were monitored by TLC. Flash chromatography was performed with silica gel 60 (200–300 mesh). Thin layer chromatography was carried out on silica gel 60 F-254 TLC plates (20 × 20 cm). The ^{1}H NMR spectroscopic data were recorded with a 400 MHz spectrometer. The chemical shifts are reported in ppm (δ) relative to tetramethylsilane (TMS: δ = 0.0 ppm) or to the solvent signal as the internal standard ($CHCl_3$: δ = 7.26 ppm, relative to TMS). Data are reported as chemical shift {multiplicity [singlet (s), doublet (d), triplet (t), quartet (q), or multiplet (m)], coupling constants (Hz), integration}. The ^{13}C NMR spectroscopic data were recorded at 101 MHz with complete proton decoupling. The chemical shifts are reported in ppm (δ) relative to TMS with the respective solvent resonance as the internal standard ($CDCl_3$: δ = 77.0 ppm). The ^{19}F NMR spectroscopic data (referenced to external CF_3COOH) were recorded with a Bruker ARX 400 MHz spectrometer. The values of the optical rotations were measured with a Rudolph Automatic Polarimeter A21101. Infrared spectra were obtained using KBr pellets with a Bruker Vector 22 instrument. High-resolution mass spectra for all new compounds were recorded with a Micromass Q-Tof instrument (ESI).

Typical Procedure for the Asymmetric Addition of Sulfinylimine: Sulfinylimine **1** (1.0 mmol), glycine ester **2** (1.1 mmol), and Cs_2CO_3 (0.1 mmol) were dissolved in THF (5 mL), and the resulting reaction mixture was stirred at room temperature for 1 h. After the reaction was complete, the mixture was directly applied to silica gel and purified by flash chromatography to furnish the corresponding product **3**.

Methyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3a): White solid (467 mg, 0.98 mmol, 98% yield); m.p. 164–165 °C. $[\alpha]_D^{25}$ = –79.6 (*c* = 0.82, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.61–7.59 (m, 2 H), 7.45–7.41 (m, 4 H), 7.35 (t, *J* = 7.5 Hz, 2 H), 7.14–7.11 (m, 2 H), 5.07 (d, *J* = 10.7 Hz, 1 H), 4.50–4.42 (m, 2 H), 3.72 (s, 3 H), 1.26 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.0, 168.9, 138.7, 135.7, 131.2, 129.2, 129.0, 128.8, 128.2, 127.2, 124.4 (q, *J* = 284.8 Hz), 63.9, 59.7 (q, *J* = 29.9 Hz), 57.3, 52.8, 22.5 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.5 ppm. IR (KBr): $\tilde{\nu}$ = 3336, 2956, 1742, 1630, 1449, 1421, 1263, 1254, 1209, 1172, 1140, 1124, 1077, 784, 702, 693 cm^{-1}. HRMS: calcd. for $C_{22}H_{25}F_3N_2O_3SNa$ [M + Na]$^+$ 477.1436; found 477.1430.

Ethyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3b): White solid (476 mg, 0.97 mmol, 97% yield); m.p. 71–72 °C. $[\alpha]_D^{25}$ = –69.1 (*c* = 0.59, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.60 (d, *J* = 7.4 Hz, 2 H), 7.45–7.43 (m, 4 H), 7.35 (t, *J* = 7.5 Hz, 2 H), 7.15–7.13 (m, 2 H), 5.09 (d, *J* = 10.6 Hz, 1 H), 4.50–4.42 (m, 2 H), 4.16 (q, *J* = 7.1 Hz, 2 H), 1.27–1.24 (m, 12 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 173.8, 168.4, 138.7, 135.8, 131.1, 129.1, 128.9, 128.7, 128.2, 127.2, 124.5 (q, *J* = 284.9 Hz), 63.9, 62.1, 59.7 (q, *J* = 29.7 Hz), 57.3, 22.5, 14.1 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.5 ppm. IR (KBr): $\tilde{\nu}$ = 3509, 3162, 2978, 1744, 1622, 1449, 1263, 1211, 1174, 1163, 1148, 1128, 1069, 698 cm^{-1}.

HRMS: calcd. for $C_{23}H_{27}F_3N_2O_3SNa$ [M + Na]$^+$ 491.1592; found 491.1587.

Propyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3c): White solid (468 mg, 0.97 mmol, 97% yield); m.p. 89–90 °C. $[\alpha]_D^{25}$ = –52.4 (*c* = 0.76, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.61–7.59 (m, 2 H), 7.45–7.42 (m, 4 H), 7.37–7.33 (m, 2 H), 7.15–7.12 (m, 2 H), 5.08 (d, *J* = 10.6 Hz, 1 H), 4.50–4.42 (m, 2 H), 4.12–4.00 (m, 2 H), 1.70–1.58 (m, 2 H), 1.27 (s, 9 H), 0.91 (t, *J* = 7.4 Hz, 3 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 173.7, 168.4, 138.7, 135.8, 131.1, 129.1, 128.9, 128.7, 128.2, 127.2, 124.5 (q, *J* = 284.8 Hz), 67.6, 63.8, 59.7 (q, *J* = 29.7 Hz), 57.3, 22.5, 21.8, 10.4 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.5 ppm. IR (KBr): $\tilde{\nu}$ = 2964, 1725, 1622, 1449, 1410, 1316, 1264, 1171, 1146, 1126, 1090, 703 cm^{-1}. HRMS: calcd. for $C_{24}H_{30}F_3N_2O_3S$ [M + H]$^+$ 483.1929; found 483.1932.

Isopropyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3d): White solid (454 mg, 0.94 mmol, 94% yield); m.p. 66–68 °C. $[\alpha]_D^{25}$ = –40.7 (*c* = 0.65, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.62–7.59 (m, 2 H), 7.45–7.41 (m, 4 H), 7.37–7.33 (m, 2 H), 7.15–7.13 (m, 2 H), 5.11 (d, *J* = 10.6 Hz, 1 H), 5.00 (hept, *J* = 6.3 Hz, 1 H), 4.49–4.39 (m, 2 H), 1.28–1.19 (m, 15 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 173.6, 167.8, 138.8, 135.9, 131.1, 129.1, 128.9, 128.6, 128.2, 127.2, 124.5 (q, *J* = 284.8 Hz), 70.0, 63.9, 59.6 (q, *J* = 29.7 Hz), 57.3, 22.6, 21.7 (d, *J* = 4.8 Hz) ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.6 ppm. IR (KBr): $\tilde{\nu}$ = 3524, 3338, 3171, 2986, 1744, 1624, 1449, 1263, 1207, 1174, 1163, 1149, 1128, 1103, 1069, 907, 764, 698 cm^{-1}. HRMS: calcd. for $C_{24}H_{30}F_3N_2O_3S$ [M + H]$^+$ 483.1929; found 483.1924.

***tert*-Butyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3e):** White solid (487 mg, 0.94 mmol, 94% yield); m.p. 73–75 °C. $[\alpha]_D^{25}$ = –28.2 (*c* = 0.90, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.61–7.59 (m, 2 H), 7.47–7.40 (m, 4 H), 7.35–7.32 (m, 2 H), 7.17–7.14 (m, 2 H), 5.16 (d, *J* = 10.6 Hz, 1 H), 4.46–4.33 (m, 2 H), 1.42 (s, 9 H), 1.30 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 173.3, 167.2, 138.8, 135.9, 131.0, 129.1, 128.8, 128.6, 128.2, 127.2, 124.6 (q, *J* = 284.8 Hz), 83.0, 64.2, 59.6 (q, *J* = 29.6 Hz), 57.3, 27.9, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.7 ppm. IR (KBr): $\tilde{\nu}$ = 2979, 1728, 1624, 1368, 1294, 1263, 1173, 1152, 1131, 1088, 874, 841, 757, 704 cm^{-1}. HRMS: calcd. for $C_{25}H_{31}F_3N_2O_3SNa$ [M + Na]$^+$ 519.1905; found 519.1900.

Benzyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3f): White solid (504 mg, 0.95 mmol, 95% yield); m.p. 109–111 °C. $[\alpha]_D^{25}$ = –51.1 (*c* = 0.56, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.59–7.57 (m, 2 H), 7.46–7.28 (m, 11 H), 7.04–7.02 (m, 2 H), 5.18–5.07 (m, 3 H), 4.50–4.43 (m, 2 H), 1.21 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.0, 168.3, 138.7, 135.7, 134.9, 131.2, 129.1, 129.0, 128.7, 128.6, 128.2, 127.2, 124.5 (d, *J* = 284.8 Hz), 67.7, 64.0, 59.6 (q, *J* = 29.8 Hz), 57.3, 22.5 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.4 ppm. IR (KBr): $\tilde{\nu}$ = 3346, 2964, 1748, 1624, 1265, 1189, 1163, 1146, 1129, 1084, 906, 751, 716, 707, 697, 652 cm^{-1}. HRMS: calcd. for $C_{28}H_{30}F_3N_2O_3S$ [M + H]$^+$ 531.1929; found 531.1924.

Phenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3g): Colorless oil (501 mg, 0.97 mmol, 97% yield). $[\alpha]_D^{25}$ = –78.8 (*c* = 0.59, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.65–7.63 (m, 2 H), 7.51–7.44 (m, 4 H), 7.39–7.35 (m, 4 H), 7.26–7.19 (m, 3 H), 7.03–7.00 (m, 2 H), 5.20 (d, *J* = 10.7 Hz, 1 H), 4.72 (d, *J* = 1.5 Hz, 1 H), 4.65–4.55 (m, 1 H), 1.30 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.5, 167.0, 150.4, 138.6, 135.8, 131.4, 129.6, 129.4, 129.0, 128.9, 128.3, 127.2, 126.4, 124.5 (q, *J* = 284.8 Hz), 121.0, 64.0, 59.4 (q, *J* = 29.8 Hz), 57.5, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.2 ppm. IR (KBr): $\tilde{\nu}$ = 2960, 1767, 1627, 1593, 1492, 1447, 1411, 1318, 1292, 1264, 1192, 1165, 1145, 1089, 752, 738, 704, 693 cm^{-1}. HRMS: calcd. for $C_{27}H_{28}F_3N_2O_3S$ [M + H]$^+$ 517.1773; found 517.1769.

2-Chlorophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3h): Colorless oil (512 mg, 0.93 mmol, 93% yield). $[\alpha]_D^{25}$ = –26.3 (*c* = 0.53, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.66–7.64 (m, 2 H), 7.49–7.35 (m, 7 H), 7.29–7.17 (m, 4 H), 7.11–7.09 (m, 1 H), 5.27 (d, *J* = 10.7 Hz, 1 H), 4.84 (d, *J* = 1.3 Hz, 1 H), 4.71–4.63 (m, 1 H), 1.31 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.8, 166.2, 146.5, 138.6, 135.5, 131.4, 130.5, 129.4, 129.0, 128.8, 128.3, 127.9, 127.5, 127.4, 126.4, 124.5 (q, *J* = 284.8 Hz), 123.0, 63.6, 59.2 (q, *J* = 30.0 Hz), 57.6, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.3 ppm. IR (KBr): $\tilde{\nu}$ = 1778, 1628, 1476, 1447, 1291, 1262, 1214, 1175, 1140, 1090, 752, 703, 695 cm^{-1}. HRMS: calcd. for $C_{27}H_{27}{}^{35}ClF_3N_2O_3S$ [M + H]$^+$ 551.1383; found 551.1383.

3-Chlorophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3i): Colorless oil (517 mg, 0.94 mmol, 94% yield). $[\alpha]_D^{25}$ = –68.4 (*c* = 0.53, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.65–7.63 (m, 2 H), 7.52–7.45 (m, 4 H), 7.39–7.35 (m, 2 H), 7.30 (t, *J* = 8.1 Hz, 1 H), 7.25–7.17 (m, 3 H), 7.05 (t, *J* = 2.1 Hz, 1 H), 6.95 (dd, *J* = 8.1, 2.2 Hz, 1 H), 5.20 (d, *J* = 10.7 Hz, 1 H), 4.72 (s, 1 H), 4.62–4.54 (m, 1 H), 1.29 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.8, 166.7, 150.7, 138.4, 135.7, 134.9, 131.4, 130.4, 129.4, 129.0, 128.9, 128.3, 127.1, 126.7, 124.4 (q, *J* = 284.8 Hz), 121.8, 119.5, 63.9, 59.1 (q, *J* = 29.9 Hz), 57.5, 22.6 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.2 ppm. IR (KBr): $\tilde{\nu}$ = 3064, 2960, 2928, 2870, 1770, 1627, 1592, 1474, 1447, 1412, 1365, 1318, 1263, 1199, 1175, 1143, 1089, 877, 783, 766, 704, 696, 676 cm^{-1}. HRMS: calcd. for $C_{27}H_{27}{}^{35}ClF_3N_2O_3S$ [M + H]$^+$ 551.1383; found 551.1380.

4-Chlorophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3j): Colorless oil (523 mg, 0.95 mmol, 95% yield). $[\alpha]_D^{25}$ = –85.3 (*c* = 0.60, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.64 (d, *J* = 7.3 Hz, 2 H), 7.50–7.44 (m, 4 H), 7.39–7.32 (m, 4 H), 7.19–7.17 (m, 2 H), 7.00–6.98 (m, 2 H), 5.22 (d, *J* = 10.6 Hz, 1 H), 4.71 (d, *J* = 0.9 Hz, 1 H), 4.64–4.56 (m, 1 H), 1.28 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.7, 166.9, 148.8, 138.5, 135.8, 131.8, 131.4, 129.7, 129.4, 129.0, 128.9, 128.3, 127.1, 124.5 (q, *J* = 284.8 Hz), 122.5, 63.9, 58.9 (q, *J* = 29.9 Hz), 57.5, 22.6 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.1 ppm. IR (KBr): $\tilde{\nu}$ = 2960, 1770, 1627, 1487, 1447, 1318, 1292, 1264, 1199, 1172, 1143, 1089, 1015, 704, 696 cm^{-1}. HRMS: calcd. for $C_{27}H_{27}{}^{35}ClF_3N_2O_3S$ [M + H]$^+$ 551.1383; found 551.1383.

4-Bromophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3k): White solid (583 mg, 0.98 mmol, 98% yield); m.p. 121–122 °C. $[\alpha]_D^{25}$ = –100.8 (*c* = 0.80, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.66–7.61 (m, 2 H), 7.50–7.44 (m, 6 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.20–7.15 (m, 2 H), 6.96–6.90 (m, 2 H), 5.21 (d, *J* = 10.6 Hz, 1 H), 4.70 (d, *J* = 1.5 Hz, 1 H), 4.64–4.53 (m, 1 H), 1.28 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.7, 166.8, 149.4, 138.4, 135.8, 132.7, 131.4, 129.4, 129.0, 128.9, 128.3, 127.1, 124.5 (q, *J* = 284.7 Hz), 122.9, 119.5, 63.9, 58.9 (q, *J* = 29.8 Hz), 57.5, 22.6 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.1 ppm. IR (KBr): $\tilde{\nu}$ = 1750, 1625, 1485, 1410, 1266, 1204, 1169, 1145, 1128, 1091, 1068, 1012, 879, 765, 708, 703, 677 cm^{-1}. HRMS: calcd. for $C_{27}H_{27}{}^{79}BrF_3N_2O_3S$ [M + H]$^+$ 595.0878; found 595.0879.

4-Fluorophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3l): White solid (518 mg, 0.97 mmol, 97% yield); m.p. 65–67 °C. $[\alpha]_D^{25}$ = –72.3 (*c* = 0.54, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.66–7.62 (m, 2 H), 7.52–7.44 (m, 4 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.18 (dd, *J* = 6.6, 2.9 Hz, 2 H), 7.08–6.97 (m, 4 H), 5.22 (d, *J* = 10.6 Hz, 1 H), 4.71 (d, *J* = 1.5 Hz, 1 H), 4.65–4.54 (m, 1 H), 1.29 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.7, 167.1, 160.4 (d, *J* = 245.3 Hz), 146.2 (d, *J* = 2.9 Hz), 138.5, 135.8, 131.4, 129.4, 129.0, 128.9, 128.3, 127.1, 124.5 (q, *J* = 284.7 Hz), 122.5 (d, *J* = 8.5 Hz), 116.3 (d, *J* = 23.6 Hz), 63.9, 59.0 (q, *J* = 29.9 Hz), 57.5, 22.6 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.2, –115.9 ppm. IR (KBr): $\tilde{\nu}$ = 3331, 2964, 1760, 1629, 1503, 1267, 1184, 1158, 1140, 1080, 1070, 836, 756, 704, 699 cm^{-1}. HRMS: calcd. for $C_{27}H_{27}F_4N_2O_3S$ $[M + H]^+$ 535.1679; found 535.1679.

***o*-Tolyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3m):** Colorless oil (493 mg, 0.93 mmol, 93% yield). $[\alpha]_D^{25}$ = –37.5 (*c* = 0.59, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.67–7.62 (m, 2 H), 7.51–7.43 (m, 4 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.23–7.12 (m, 5 H), 6.97–6.93 (m, 1 H), 5.22 (d, *J* = 10.7 Hz, 1 H), 4.78 (d, *J* = 1.3 Hz, 1 H), 4.69–4.58 (m, 1 H), 2.03 (s, 3 H), 1.30 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.5, 166.6, 148.9, 138.5, 135.7, 131.4, 131.3, 129.6, 129.3, 128.9, 128.8, 128.3, 127.3, 127.1, 126.5, 124.5 (q, *J* = 285.0 Hz), 121.4, 63.6, 59.4 (q, *J* = 29.8 Hz), 57.5, 22.7, 16.2 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.4 ppm. IR (KBr): $\tilde{\nu}$ = 1770, 1627, 1490, 1447, 1264, 1221, 1171, 1148, 1129, 1109, 1091, 754, 704, 696 cm^{-1}. HRMS: calcd. for $C_{28}H_{30}F_3N_2O_3S$ $[M + H]^+$ 531.1929; found 531.1930.

***m*-Tolyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3n):** Colorless oil (488 mg, 0.92 mmol, 92% yield). $[\alpha]_D^{25}$ = –120.5 (*c* = 0.54, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.65–7.63 (m, 2 H), 7.52–7.44 (m, 4 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.26–7.20 (m, 3 H), 7.05 (d, *J* = 7.6 Hz, 1 H), 6.85–6.79 (m, 2 H), 5.21 (d, *J* = 10.7 Hz, 1 H), 4.72 (d, *J* = 1.6 Hz, 1 H), 4.66–4.55 (m, 1 H), 2.35 (s, 3 H), 1.30 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.5, 167.1, 150.3, 139.9, 138.6, 135.8, 131.3, 129.3, 129.3, 129.0, 128.9, 128.3, 127.2, 127.1, 124.5 (q, *J* = 284.9 Hz), 121.6, 117.9, 64.0, 59.6 (q, *J* = 29.9 Hz), 57.5, 22.7, 21.3 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.3 ppm. IR (KBr): $\tilde{\nu}$ = 2958, 2927, 1770, 1627, 1616, 1488, 1447, 1411, 1290, 1264, 1238, 1172, 1151, 1128, 1090, 704, 696 cm^{-1}. HRMS: calcd. for $C_{28}H_{30}F_3N_2O_3S$ $[M + H]^+$ 531.1929; found 531.1931.

***p*-Tolyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3o):** White solid (472 mg, 0.89 mmol, 89% yield); m.p. 55–57 °C. $[\alpha]_D^{25}$ = –85.8 (*c* = 0.69, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.66–7.61 (m, 2 H), 7.52–7.43 (m, 4 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.22–7.13 (m, 4 H), 6.89 (d, *J* = 8.5 Hz, 2 H), 5.19 (d, *J* = 10.7 Hz, 1 H), 4.71 (d, *J* = 1.5 Hz, 1 H), 4.65–4.55 (m, 1 H), 2.33 (s, 3 H), 1.29 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.5, 167.2, 148.2, 138.6, 136.1, 135.8, 131.3, 130.1, 129.3, 129.0, 128.9, 128.3, 127.2, 124.5 (q, *J* = 284.9 Hz), 120.7, 64.0, 59.5 (q, *J* = 29.8 Hz), 57.5, 22.7, 20.9 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.3 ppm. IR (KBr): $\tilde{\nu}$ = 3334, 2959, 2927, 1767, 1756, 1627, 1598, 1576, 1506, 1447, 1411, 1318, 1290, 1264, 1214, 1196, 1169, 1146, 1091, 782, 754, 697 cm^{-1}. HRMS: calcd. for $C_{28}H_{30}F_3N_2O_3S$ $[M + H]^+$ 531.1929; found 531.1928.

4-Methoxyphenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3p): White solid (508 mg, 0.93 mmol, 93% yield); m.p. 54–56 °C. $[\alpha]_D^{25}$ = –89.6 (*c* = 0.69, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.66–7.61 (m, 2 H), 7.50–7.44 (m, 4 H), 7.37 (t, *J* = 7.5 Hz, 2 H), 7.20 (dd, *J* = 6.5, 3.0 Hz, 2 H), 6.96–6.84 (m, 2 H), 5.20 (d, *J* = 10.7 Hz, 1 H), 4.70 (d, *J* = 1.5 Hz, 1 H), 4.65–4.54 (m, 1 H), 3.79 (s, 3 H), 1.29 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.4, 167.3, 157.6, 143.8, 138.6, 135.8, 131.3, 129.3, 129.0, 128.9, 128.3, 127.2, 124.5 (q, *J* = 284.9 Hz), 121.8, 114.6, 63.9, 59.4 (q, *J* = 29.9 Hz), 57.5, 55.6, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.3 ppm. IR (KBr): $\tilde{\nu}$ = 1766, 1627, 1505, 1446, 1294, 1263, 1191, 1175, 1145, 1092, 1032, 703 cm^{-1}. HRMS: calcd. for $C_{28}H_{30}F_3N_2O_4S$ $[M + H]^+$ 547.1878; found 547.1880.

2,6-Dichlorophenyl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3q): White solid (520 mg, 0.89 mmol, 89% yield); m.p. 67–69 °C. $[\alpha]_D^{25}$ = –3.2 (*c* = 0.64, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.67–7.63 (m, 2 H), 7.49–7.44 (m, 4 H), 7.39–7.33 (m, 4 H), 7.26–7.24 (m, 2 H), 7.17–7.13 (m, 1 H), 5.27 (d, *J* = 10.7 Hz, 1 H), 4.94 (d, *J* = 1.2 Hz, 1 H), 4.72–4.64 (m, 1 H), 1.31 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 175.0, 164.9, 143.3, 138.6, 135.3, 131.4, 129.4, 129.0, 128.8, 128.8, 128.5, 128.3, 127.7, 127.5, 124.4 (q, *J* = 285.3 Hz), 63.0, 59.6 (q, *J* = 30.1 Hz), 57.8, 22.8 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.6 ppm. IR (KBr): $\tilde{\nu}$ = 2960, 1789, 1627, 1576, 1446, 1410, 1292, 1263, 1228, 1177, 1126, 1093, 776, 702, 695 cm^{-1}. HRMS: calcd. for $C_{27}H_{26}{}^{35}Cl_2F_3N_2O_3S$ $[M + H]^+$ 585.0993; found 585.0996.

Naphthalen-1-yl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3r): White solid (521 mg, 0.92 mmol, 92% yield); m.p. 60–62 °C. $[\alpha]_D^{25}$ = +4.0 (*c* = 0.61, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.86 (d, *J* = 8.2 Hz, 1 H), 7.77–7.67 (m, 3 H), 7.60–7.36 (m, 10 H), 7.26–7.21 (m, 3 H), 5.27 (d, *J* = 10.7 Hz, 1 H), 4.95 (d, *J* = 1.4 Hz, 1 H), 4.78–4.68 (m, 1 H), 1.28 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.7, 167, 146.2, 138.5, 135.8, 134.7, 131.4, 129.4, 129.0, 129.0, 128.4, 128.1, 127.4, 126.7, 126.6, 126.3, 125.4, 124.6 (q, *J* = 285.9 Hz), 121.1, 117.7, 63.9, 59.5 (q, *J* = 29.8 Hz), 57.6, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.2 ppm. IR (KBr): $\tilde{\nu}$ = 2960, 1773, 1627, 1447, 1391, 1291, 1261, 1224, 1174, 1142, 1082, 783, 764, 752, 703, 695 cm^{-1}. HRMS: calcd. for $C_{31}H_{30}F_3N_2O_3S$ $[M + H]^+$ 567.1929; found 567.1930.

Naphthalen-2-yl (2*S*,3*S*)-3-[(*S*)-1,1-Dimethylethylsulfinamido]-2-[(diphenylmethylene)amino]-4,4,4-trifluorobutanoate (3s): White solid (515 mg, 0.91 mmol, 91% yield); m.p. 83–85 °C. $[\alpha]_D^{25}$ = –101.7 (*c* = 0.72, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ = 7.84 (d, *J* = 8.7 Hz, 2 H), 7.80–7.76 (m, 1 H), 7.69–7.65 (m, 2 H), 7.53–7.46 (m, 7 H), 7.38 (t, *J* = 7.5 Hz, 2 H), 7.26–7.22 (m, 2 H), 7.15 (dd, *J* = 8.9, 2.3 Hz, 1 H), 5.22 (d, *J* = 10.7 Hz, 1 H), 4.78 (d, *J* = 1.5 Hz, 1 H), 4.71–4.61 (m, 1 H), 1.31 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.6, 167.2, 148.0, 138.6, 135.8, 133.6, 131.6, 131.3, 129.7, 129.4, 129.0, 128.9, 128.3, 127.8, 127.7, 127.3, 126.9, 126.1, 124.5 (d, *J* = 284.8 Hz), 120.3, 118.2, 64.1, 59.5 (q, *J* = 29.9 Hz), 57.5, 22.7 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): δ = –72.2 ppm. IR (KBr): $\tilde{\nu}$ = 2978, 1765, 1628, 1446, 1317, 1294, 1262, 1210, 1165, 1152, 1130, 1091, 1077, 746, 700 cm^{-1}. HRMS: calcd. for $C_{31}H_{30}F_3N_2O_3S$ $[M + H]^+$ 567.1929; found 567.1929.

Procedure for the Selective Deprotection of the Functional Group: Compound **3e** (0.5 mmol) was dissolved in DCM (5 mL) in a reaction vial, and the resulting mixture was cooled to 0 °C. TFA (1.0 mmol) was added dropwise with stirring, and the reaction was allowed to continue at 20 °C for 12 h (monitored by TLC). Upon completion, Et_3N (2.0 mmol) was added, and the mixture was stirred at room temp. for 1 h. H_2O (10 mL) was then added. The organic layer was separated, washed with H_2O (2× 10 mL), dried

with anhydrous Na_2SO_4, and filtered. The solvent was removed to give the crude product, which was purified by flash chromatography.

***tert*-Butyl (2*S*,3*S*)-2-Amino-3-[(*S*)-1,1-dimethylethylsulfinamido]-4,4,4-trifluorobutanoate (4e):** Colorless oil (93% yield). $[\alpha]_D^{25} = -8.2$ ($c = 0.56$, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): $\delta = 4.72$ (d, $J = 10.4$ Hz, 1 H), 4.23–4.10 (m, 1 H), 3.94 (d, $J = 1.4$ Hz, 1 H), 1.72 (s, 2 H), 1.49 (s, 9 H), 1.21 (s, 9 H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$): $\delta = 170.0$, 124.8 (q, $J = 284.4$ Hz), 83.2, 58.7 (q, $J = 29.1$ Hz), 57.2, 53.1, 28.0, 22.6 ppm. ^{19}F NMR (376 MHz, $CDCl_3$): $\delta = -72.99$ ppm. IR (KBr): $\tilde{\nu} = 3390$, 3311, 2980, 1739, 1370, 1253, 1156, 1089, 846 cm^{-1}. HRMS: calcd. for $C_{13}H_{23}F_3N_2O_3SNa$ $[M + Na]^+$ 355.1279; found 355.1280.

Supporting Information (see footnote on the first page of this article): Experimental procedures, full spectroscopic data for new compounds **3**, and copies of ^1H and ^{13}C NMR spectra.

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