**Regio- and Stereoselective Reactions of *gem*-Difluorinated Vinyloxiranes with Hetero-
Nucleophiles**

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General Methods. Unless otherwise noted, materials were obtained from commercial suppliers and were used without further purification. All manipulations involving air-sensitive materials were performed under argon, with such materials being exposed only to thoroughly dried and degassed solvents. Anhydrous ether, THF and CH₂Cl₂ were purchased and were used without further purification.

Chemical shifts of ¹H and ¹³C NMR spectra were reported in parts per million (ppm) downfield from internal tetramethylsilane (Me₄Si) in CDCl₃ unless otherwise noted. Chemical shifts of ¹⁹F NMR spectra were reported in ppm downfield from internal hexafluorobenzene (C₆F₆) in CDCl₃ unless otherwise noted. Data were tabulated in the following order: multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; quint, quintet; sex, sextet; m, multiplet; br, broad peak), number of protons, coupling constants (in hertz). Infrared (IR) spectra were obtained as thin films on NaCl plates, and all spectra were reported in wave numbers (cm⁻¹). Melting points, mp, were measured without correction. Column chromatography was conducted with silica gel by using a mixture of *n*-hexane and AcOEt (v/v), and before starting separation, it is recommended to “wash” silica gel by passing AcOEt for removing the chance of decomposition of epoxy-containing products, which makes the isolation easier.

Elemental analysis of **11**, *anti*-**2aa**, and *syn*-**2aa** were not carried out because of their inherent instability. Only ^1H , ^{19}F , and ^{13}C NMR spectrums are described for **11a** due to existence of the inseparable impurity.

Table S1. Reaction of **1a** with Lewis Acids.

entry	Lewis acid	ΔE (eV) ^a	Time (h)	yield (%)		recovery (%)
				4a	5a	
1	$\text{Sc}(\text{OTf})_3$	1.00	1	5	9	0
2	$\text{Yb}(\text{OTf})_3$	0.83	2	3	29	0
3	$\text{Zn}(\text{OTf})_3$	0.71	2.5	3	23	0
4 ^b	LiClO_4	0.53	24	<1	1	97

All reactions of **1a** (0.45 mmol) with Lewis acids (1.0 equiv) were conducted in 5 ml of CH_2Cl_2 . Yields and recoveries were determined by ^{19}F NMR. ^a From ref 24. ^b The reaction was run at rt.

Experimental section

4-Bromo-4,4-difluoro-3-methyl-1-phenylbut-3-en-1-ol (3ca): Isolated yield: 86%. IR (neat) ν 702, 748, 764, 864, 914, 964, 1011, 1065, 1103, 1134, 1196, 1227, 1288, 1339, 1389, 1454, 1751, 2859, 2928, 3333 cm^{-1} . Anal. Calcd for $\text{C}_{11}\text{H}_{11}\text{BrF}_2\text{O}$: C, 47.68; H, 4.00. Found: C, 47.69; H, 4.23. **E isomer:** ^1H NMR δ 1.98 (3 H, d, $J = 1.38$ Hz), 5.47 (1 H, d, $J = 8.24$ Hz), 6.22 (1 H, dsex, $J = 8.24, 1.37$ Hz), 7.25-7.57 (5 H, m). ^{19}F NMR δ 111.4 (1 F, d, $J = 147.3$ Hz), 112.0 (1 F, d, $J = 148.2$ Hz). ^{13}C NMR δ 12.5 (t, $J = 1.72$ Hz), 70.1, 119.5 (t, $J = 304.3$ Hz), 126.0, 128.2, 128.8, 131.3 (dd, $J = 7.45, 7.16$ Hz), 133.2 (dd, $J = 20.4, 20.0$ Hz), 141.5. **Z isomer:** ^{19}F NMR δ 118.1 (1 F, d, $J = 153.4$ Hz), 120.9 (1 F, d, $J = 158.4$ Hz).

3-(Bromodifluoromethyl)-1,5,5-trimethylcyclohex-2-en-1-ol (3da): Isolated yield: 85%. ^1H NMR δ 1.05 (3 H, s), 1.08 (3 H, s), 1.33 (3 H, s), 1.57 (1 H, d, $J = 14.6$ Hz), 1.71 (1 H, ddd, $J = 14.3, 1.37, 1.37$ Hz), 1.96 (1 H, bd, $J = 17.7$ Hz), 2.09 (1 H, m), 6.09 (1 H, quint, $J = 1.10$ Hz). ^{19}F NMR δ 111.5 (s). ^{13}C NMR δ 27.0, 30.1, 30.4, 30.7 (dd, $J = 0.85, 0.58$ Hz), 37.1 (dd, $J = 1.14, 0.86$ Hz), 49.7, 68.5, 119.5 (t, $J = 303.7$ Hz), 130.5 (t, $J = 6.87$ Hz), 134.3 (t, $J = 20.3$ Hz). IR (neat) ν 733, 795, 826, 864, 907, 949, 1034, 1065, 1123, 1177, 1250, 1342, 1369, 1435, 1458, 1670, 1717, 2839, 2874, 2928, 2959, 3364 cm^{-1} . Anal. Calcd for $\text{C}_{10}\text{H}_{15}\text{BrF}_2\text{O}$: C, 44.63; H, 5.62. Found: C, 44.75; H, 5.42.

4-Bromo-4,4-difluoro-3-methyl-1-(4-nitrophenyl)but-3-en-1-ol (3ea): Isolated yield: 96%. IR (KBr) ν 351, 393, 420, 459, 482, 525, 637, 683, 702, 752, 783, 818, 860, 907, 961, 1011, 1034, 1080, 1111, 1173, 1219, 1350, 1450, 1520, 1605, 1686, 1751, 1809, 1921, 1964, 2210, 2311, 2369, 2453, 2847, 2913, 3009, 3075, 3109, 3487 cm^{-1} . Anal. Calcd for $\text{C}_{11}\text{H}_{10}\text{BrF}_2\text{NO}_3$: C, 41.02; H, 3.13; N, 4.35. Found: C, 41.17; H, 3.47; N 4.15. mp 91 $^{\circ}\text{C}$. **E isomer:** ^1H NMR δ 2.05 (3 H, d, $J = 1.37$ Hz), 5.60 (1 H, brd, $J = 8.34$ Hz), 6.11 (1 H, dsex, $J = 8.52, 1.37$ Hz), 7.49-7.64 (2 H, m), 8.18-8.28 (2 H, m). ^{19}F NMR δ 110.7 (1 F, d, $J = 149.1$ Hz), 111.4 (1 F, d, $J = 148.6$ Hz). ^{13}C NMR δ 12.6 (t, $J = 1.72$ Hz), 69.0, 119.0 (t, $J = 304.6$ Hz), 123.9, 126.6, 129.9 (dd, $J = 7.44, 7.16$ Hz), 134.7 (dd, $J = 20.6, 20.3$ Hz), 147.4, 148.4. **Z isomer:** ^{19}F NMR δ 117.6 (1 F, d, $J = 156.0$ Hz), 120.3 (1 F, d, $J = 156.0$ Hz).

4-Bromo-4,4-difluoro-3-methyl-1-(4-methylphenyl)but-3-en-1-ol (3fa): Isolated yield: 40%. IR (neat) ν 691, 772, 818, 868, 910, 945, 964, 1011, 1069, 1099, 1134, 1227, 1281, 1389, 1420, 1447, 1512,

1616, 1670, 1717, 1751, 2342, 2361, 2862, 2924, 3005, 3024, 3098, 3329 cm^{-1} . Anal. Calcd for $\text{C}_{12}\text{H}_{13}\text{BrF}_2\text{O}$: C, 49.51; H, 4.05. Found: C, 49.12; H, 4.90. **E isomer:** ^1H NMR δ 1.94 (3 H, d, $J = 1.34$ Hz), 2.35 (3 H, s), 5.41 (1 H, d, $J = 8.30$ Hz), 6.21 (1 H, dq, $J = 8.30, 1.34$ Hz), 7.12-7.30 (4 H, m). ^{19}F NMR δ 111.6 (1 F, d, $J = 147.2$ Hz), 112.3 (1 F, d, $J = 148.0$ Hz). ^{13}C NMR δ 12.4 (t, $J = 1.72$ Hz), 21.2, 70.0, 119.5 (dd, $J = 304.6, 304.3$ Hz), 125.9, 129.4, 131.5 (dd, $J = 7.45, 7.15$ Hz), 132.9 (t, $J = 20.0$ Hz), 138.0. **Z isomer:** ^{19}F NMR δ 118.3 (1 F, d, $J = 153.4$ Hz), 121.0 (1 F, dd, $J = 153.4, 2.29$ Hz).

(E)-6-(Bromodifluoromethyl)-5-methyl-1-phenyl-3-(2-phenylethyl)-hex-4-en-3-ol (3ha): Isolated yield: 68%. ^1H NMR δ 1.96 (4 H, m), 2.13 (3 H, d, $J = 1.37$ Hz), 2.70 (4 H, m), 5.98 (1 H, sex, $J = 1.37$ Hz), 7.15-7.35 (10 H, m). ^{19}F NMR δ 112.6 (s). ^{13}C NMR δ 12.5 (t, $J = 1.71$ Hz), 30.2, 44.0, 76.2, 120.2 (dd, $J = 305.5, 305.2$ Hz), 126.0, 128.2, 128.5, 133.4 (dd, $J = 7.44, 7.16$ Hz), 134.3 (t, $J = 18.9$ Hz), 141.5. IR (neat) ν 698, 741, 864, 910, 937, 991, 1030, 1065, 1126, 1184, 1250, 1366, 1389, 1454, 1497, 1601, 1671, 1736, 1805, 1871, 1948, 2862, 2932, 3028, 3063, 3464, 3564 cm^{-1} . Anal. Calcd for $\text{C}_{21}\text{H}_{23}\text{BrF}_2\text{O}$: C, 61.62; H, 5.66. Found: C, 61.72; H, 6.11.

3-(Bromodifluoromethyl)-5-phenylpent-2-en-1-ol (3ia): Isolated yield: 72%. IR (neat) ν 702, 752, 802, 833, 887, 918, 968, 1007, 1034, 1096, 1126, 1169, 1215, 1258, 1331, 1377, 1454, 1497, 1585, 1605, 1667, 1740, 2870, 2928, 3028, 3063, 3345, 3530 cm^{-1} . Anal. Calcd for $\text{C}_{12}\text{H}_{13}\text{BrF}_2\text{O}$: C, 49.51; H, 4.50. Found: C, 49.45; H, 4.18. **E Isomer:** ^1H NMR δ 2.60 (2 H, dd, $J = 7.97, 7.14$ Hz), 2.84 (2 H, dd, $J = 7.97, 7.14$ Hz), 3.89 (2 H, dt, $J = 6.59, 1.92$ Hz), 6.17 (1 H, tdd, $J = 6.59, 1.65, 1.37$ Hz), 7.10-7.34 (5 H, m). ^{19}F NMR δ 114.9 (m). ^{13}C NMR δ 29.0 (dd, $J = 1.15, 0.86$ Hz), 35.0, 58.5, 119.8 (t, $J = 305.2$ Hz), 126.4, 128.4, 128.7, 131.4 (t, $J = 7.73$ Hz), 135.9 (t, $J = 18.9$ Hz), 140.4. **Z Isomer:** ^{19}F NMR δ 119.4 (1 F, t, $J = 3.01$ Hz).

3-(Bromodifluoromethyl)-1,3-diphenylprop-2-en-1-ol (3ka): Isolated yield: 58%. IR (neat) ν 698, 828, 907, 968, 1015, 1072, 1126, 1157, 1196, 1219, 1265, 1389, 1454, 1493, 1651, 2855, 2928, 3032, 3063, 3383 cm^{-1} . Anal. Calcd for $\text{C}_{16}\text{H}_{13}\text{BrF}_2\text{O}$: C, 56.66; H, 3.86. Found: C, 56.41; H, 4.28. **E Isomer:** ^1H NMR δ 5.01 (1 H, d, $J = 9.06$ Hz), 6.50 (1 H, dt, $J = 9.34, 1.38$ Hz), 7.15-7.60 (10 H, m). ^{19}F NMR δ 113.5 (1 F, d, $J = 151.5$ Hz), 114.3 (1 F, d, $J = 151.5$ Hz). ^{13}C NMR δ 70.6, 118.4 (dd, $J = 305.2, 304.9$ Hz).

Hz), 126.0, 128.2, 128.3, 128.7, 129.0, 130.2, 133.8 (t, $J = 6.59$ Hz), 138.4 (dd, $J = 20.6, 19.8$ Hz), 138.7 (dd, $J = 1.72, 1.14$ Hz), 141.4. **Z Isomer:** ^{19}F NMR δ 121.3 (1 F, d, $J = 157.8$ Hz), 124.5 (1 F, d, $J = 157.7$ Hz).

Synthesis of (*cis*)-3,4-epoxy-1,1-difluoro-2-methyl-6-phenylhex-1-ene (**11**)

To a flask containing NaH (0.015 g, 0.66 mmol) in 2 mL of dry THF, *syn*-**2aa** (0.067 g, 0.22 mmol) was added with the aid of 3 mL of dry THF at 0 °C under argon and the reaction mixture was stirred at rt overnight. Then, the reaction was quenched with saturated NH_4Cl aq and the organic layer was extracted with Et_2O three times and dried over anhydrous MgSO_4 . Removal of the solvents and purification with Florisil column chromatography (*n*-hexane:AcOEt = 4:1) afforded pure **11** in >99% yield.

(*cis*)-3,4-Epoxy-1,1-difluoro-2-methyl-6-phenylhex-1-ene (11**):** ^1H NMR δ 1.39 (3 H, m), 1.88-1.93 (2 H, m), 2.72-2.86 (2 H, m), 2.98 (1 H, td, $J = 5.86, 2.45$ Hz), 3.34 (1 H, q, $J = 1.38$ Hz), 7.17-7.31 (5 H, m). ^{19}F NMR δ 68.2 (1 F, dd, $J = 45.8, 7.10$ Hz), 74.8 (1 F, dd, $J = 42.4, 3.05$ Hz). ^{13}C NMR δ 6.60 (t, $J = 1.15$ Hz), 32.1, 33.6, 54.0 (dd, $J = 6.53, 2.52$ Hz), 55.4 (t, $J = 1.72$ Hz), 83.3 (dd, $J = 20.1, 13.7$ Hz), 125.9, 128.1, 128.3, 140.1, 154.8 (t, $J = 287.5$ Hz). IR (neat) ν 699, 744, 790, 880, 948, 1058, 1134, 1210, 1257, 1303, 1451, 1496, 1603, 1750, 2366, 2861, 2931, 2997, 3025, 3062, 3585, 3629, 3655, 3751 cm^{-1} .

6,6-Difluoro-5-methyl-1-phenylhex-5-en-3-one (4a**):** ^1H NMR δ 1.54 (3 H, t, $J = 3.16$ Hz), 2.77 (2 H, m), 2.90 (2 H, m), 3.01 (2 H, t, $J = 1.93$ Hz), 7.16-7.33 (5 H, m). ^{19}F NMR δ 67.1 (1 F, ddtd, $J = 51.7, 7.46, 3.01, 1.73$ Hz), 67.5 (1 F, ddtd, $J = 51.3, 7.33, 3.45, 2.16$ Hz). ^{13}C NMR δ 12.5 (dd, $J = 1.71, 1.14$ Hz), 29.7, 42.5 (d, $J = 2.58$ Hz), 43.5, 80.0 (dd, $J = 22.3, 19.5$ Hz), 126.0, 128.1, 128.3, 140.5, 153.6 (dd, $J = 283.7, 283.3$ Hz), 205.9 (dd, $J = 3.58, 2.44$ Hz). IR (neat) ν 699, 745, 1088, 1210, 1275, 1451, 1721, 1762, 2339, 2364, 2930 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{14}\text{F}_2\text{O}$: C, 69.63; H, 6.29. Found: C, 69.52; H, 6.64.

4-Bromo-6,6-difluoro-5-methyl-1-phenylhex-5-en-3-one (6) and (E)-6-bromo-6,6-difluoro-5-methyl-1-phenylhex-4-en-3-one (7): Combined isolated yield: 72%. IR (neat) ν 667, 698, 748, 849, 907, 926, 976, 1030, 1084, 1099, 1138, 1180, 1231, 1288, 1366, 1454, 1497, 1605, 1636, 1705, 1744, 2870, 2932, 3001, 3028, 3063, 3082 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{13}\text{BrF}_2\text{O}$: C, 51.51; H, 4.32. Found: C, 51.32; H, 4.14. **Compound 6:** ^1H NMR δ 1.61 (3 H, t, $J = 3.30$ Hz), 2.83-3.07 (4 H, m), 5.25 (1 H, d, $J = 2.20$ Hz), 7.15-7.33 (5 H, m). ^{19}F NMR δ 73.5 (1 F, ddt, $J = 34.5, 5.60, 3.02$ Hz), 74.0 (1 F, dq, $J = 34.5, 3.45$ Hz). ^{13}C NMR δ 9.20 (t, $J = 0.86$ Hz), 30.1, 41.1, 51.2 (d, $J = 5.44$ Hz), 84.6 (dd, $J = 24.1, 15.2$ Hz), 126.3, 128.2, 128.5, 140.0, 153.1 (dd, $J = 291.2, 289.2$ Hz), 199.3 (dd, $J = 2.58, 2.00$ Hz). **Compound 7:** ^1H NMR δ 2.23 (3 H, d, $J = 1.37$ Hz), 2.83-3.07 (4 H, m), 6.48 (1 H, quint, $J = 1.37$ Hz), 7.15-7.33 (5 H, m). ^{19}F NMR δ 108.4 (2 F, d, $J = 1.30$ Hz). ^{13}C NMR δ 13.7 (t, $J = 1.72$ Hz), 29.6, 46.4, 118.7 (t, $J = 305.2$ Hz), 122.8 (dd, $J = 6.89, 6.58$ Hz), 126.1, 128.1, 128.4, 140.3, 145.7 (dd, $J = 20.6, 20.3$ Hz), 199.3.

4-Bromo-5-methyl-1-phenylhex-5-en-3-ol (9): Isomer 1: ^1H NMR δ 1.79 (1 H, m), 1.90 (3 H, dd, $J = 1.37, 0.82$ Hz), 2.12 (1 H, dddd, $J = 13.7, 10.2, 6.86, 3.02$ Hz), 2.70 (1 H, ddd, $J = 13.7, 9.89, 6.87$ Hz), 2.89 (1 H, ddd, $J = 13.7, 10.2, 5.22$ Hz), 3.87 (1 H, ddd, $J = 9.61, 6.86, 3.02$ Hz), 4.45 (1 H, d, $J = 6.87$ Hz), 5.03 (1 H, quint, $J = 1.37$ Hz), 5.14 (1 H, dd, $J = 1.37, 0.83$ Hz), 7.16-7.34 (5 H, m). ^{13}C NMR δ 18.9, 31.2, 35.6, 63.0, 72.3, 117.1, 125.8, 128.3, 128.3, 141.4, 142.0. IR (neat) ν 698, 748, 822, 910, 1030, 1069, 1153, 1261, 1288, 1339, 1377, 1454, 1497, 1601, 1636, 1805, 2862, 2924, 2955, 3024, 3063, 3445, 3553 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{17}\text{BrO}$: C, 58.01; H, 6.37. Found: C, 58.41; H, 6.71. **Isomer 2:** ^1H NMR δ 1.45-1.70 (2 H, m), 1.58 (3 H, m), 2.56 (1 H, ddd, $J = 13.7, 8.79, 7.69$ Hz), 2.74 (1 H, ddd, $J = 14.0, 9.06, 5.22$ Hz), 3.58 (1 H, tdd, $J = 8.79, 3.29, 3.03$ Hz), 4.41 (1 H, d, $J = 8.79$ Hz), 4.78 (1 H, quint, $J = 1.37$ Hz), 4.96 (1 H, bd, $J = 1.55$ Hz), 7.15-7.23 (5 H, m). ^{13}C NMR δ 18.0, 31.9, 35.0, 69.1, 71.8, 116.6, 125.8, 1228.3, 128.3, 141.3, 142.1. IR (neat) ν 910, 968, 1015, 1061, 1157, 1177, 1211, 1254, 1288, 1342,

1377, 1454, 1497, 1601, 1639, 1721, 2369, 2859, 2920, 2951, 3024, 3063, 3082, 3449, 3553 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{17}\text{BrO}$: C, 58.01; H, 6.37. Found: C, 57.64; H, 6.84.

6-Bromo-5-methyl-1-phenylhex-4-en-1-ol (10): IR (neat) ν 617, 644, 698, 748, 856, 891, 918, 1007, 1053, 1138, 1157, 1207, 1246, 1288, 1381, 1454, 1493, 1601, 1717, 2342, 2361, 2859, 2924, 3024, 3059, 3082, 3356 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{17}\text{BrO}$: C, 58.01; H, 6.37. Found: C, 57.87; H, 6.05. **Isomer 1:** ^1H NMR δ 1.60-2.04 (2 H, m), 1.77 (3 H, d, $J = 1.37$ Hz), 2.60-2.80 (2 H, m), 3.90-3.99 (2 H, m), 4.36 (1 H, ddd, $J = 8.79, 7.42, 6.04$ Hz), 5.62 (1 H, m), 7.15-7.35 (5 H, m). ^{13}C NMR δ 15.3, 31.5, 38.6, 40.3, 67.9, 125.8, 128.3, 128.3, 132.9, 134.5, 141.4. **Isomer 2:** ^1H NMR δ 1.60-2.04 (2 H, m), 1.88 (1 H, d, $J = 1.38$ Hz), 2.60-2.80 (2 H, m), 3.90-3.99 (2 H, m), 4.43 (1 H, ddd, $J = 8.79, 7.14, 6.04$ Hz), 5.43 (1 H, dq, $J = 8.79, 1.37$ Hz), 7.15-7.35 (5 H, m). ^{13}C NMR δ 22.2, 31.3, 31.6, 38.7, 67.5, 125.8, 128.3, 128.3, 133.3, 134.6, 141.4.

(E)-1,1-difluoro-4-hydroxy-2-methyl-6-phenylhex-2-enyl formate (11a): ^1H NMR δ 1.70-1.88 (1 H, m), 1.76 (3 H, d, $J = 1.34$ Hz), 1.99 (1 H, dddd, $J = 13.8, 9.16, 7.69, 6.11$ Hz), 2.67-2.82 (2 H, m), 4.43 (1 H, m), 6.12 (1 H, m), 7.17-7.35 (5 H, m), 8.38 (1 H, s). ^{19}F NMR δ 89.4 (1 F, d, $J = 156.4$ Hz), 89.8 (1 F, d, $J = 156.4$ Hz). ^{13}C NMR δ 11.3 (t, $J = 1.72$ Hz), 31.3, 38.1, 67.1, 121.7 (t, $J = 268.5$ Hz), 125.9, 127.2 (t, $J = 26.6$ Hz), 128.2, 128.3, 135.2 (dd, $J = 6.30, 6.01$ Hz), 141.0, 155.0 (dd, $J = 6.01, 5.73$ Hz).

(E)-1,1-difluoro-4-hydroxy-2-methyl-6-phenylhex-2-enyl p-toluenesulfonate (11c): Isolated yield: 94%. ^1H NMR δ 1.66 (3 H, d, $J = 1.38$ Hz), 1.77 (1 H, m), 1.94 (1 H, dddd, $J = 13.7, 9.07, 7.70, 6.32$ Hz), 2.46 (3 H, s), 2.65 (1 H, ddd, $J = 14.0, 9.07, 6.87$ Hz), 2.72 (1 H, ddd, $J = 14.0, 9.06, 6.32$ Hz), 4.35 (1 H, m), 6.02 (1 H, dsex, $J = 8.51, 1.37$ Hz), 7.13-7.28 (5 H, m), 7.36 (2 H, d, $J = 8.52$ Hz), 7.86 (2 H, d, $J = 8.24$ Hz). ^{19}F NMR δ 90.1 (1 F, d, $J = 147.4$ Hz), 90.7 (1 F, d, $J = 147.3$ Hz). ^{13}C NMR δ 11.2 (t, $J = 1.72$ Hz), 21.7, 31.2, 38.0, 67.0, 121.7 (t, $J = 272.8$ Hz), 125.8, 127.5 (dd, $J = 26.9, 26.6$ Hz), 127.9, 128.1, 128.1, 128.2, 129.7, 134.9 (dd, $J = 6.30, 6.01$ Hz), 140.9, 145.7. IR (neat) ν 576, 666, 701, 731,

815, 843, 878, 1019, 1141, 1183, 1201, 1266, 1308, 1390, 1454, 1496, 1598, 1801, 2863, 2930, 3028, 3063, 3405, 3568 cm^{-1} . Anal. Calcd for $\text{C}_{20}\text{H}_{22}\text{F}_2\text{O}_4\text{S}$: C, 60.59; H, 5.59. Found: C, 60.39; H, 5.59.

(*E*)-4-Hydroxy-2-methyl-6-phenylhex-2-enoyl fluoride (12): Isolated yield: 84%. ^1H NMR δ 1.80-1.90 (1 H, m), 1.84 (3 H, s), 2.00 (1 H, dtd, $J = 14.0, 8.24, 5.77$ Hz), 2.71 (1 H, ddd, $J = 14.1, 8.24, 7.42$ Hz), 2.79 (1 H, ddd, $J = 14.0, 9.04, 5.77$ Hz), 4.50 (1 H, td, $J = 8.24, 4.95$ Hz), 6.86 (1 H, ddd, $J = 8.24, 3.02, 1.65$ Hz), 7.16-7.35 (5 H, m). ^{19}F NMR δ 177.3 (s). ^{13}C NMR δ 12.9 (d, $J = 1.14$ Hz), 31.2, 37.6, 67.8, 123.8 (d, $J = 52.4$ Hz), 126.1, 128.2, 128.4, 140.6, 149.8, 158.0 (d, $J = 347.8$ Hz). IR (neat) ν 698, 729, 795, 930, 957, 1030, 1069, 1169, 1215, 1315, 1389, 1454, 1497, 1605, 1651, 1802, 2342, 2365, 2862, 2932, 3028, 3063, 3372, 3530 cm^{-1} . Anal. Calcd for $\text{C}_{13}\text{H}_{15}\text{FO}_2$: C, 70.25; H, 6.80. Found: C, 70.28; H, 7.12.