Supporting Information

Reactions of TFDA with Ketones. Synthesis of Difluoromethyl 2,2-difluorocyclopropyl Ethers

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X-ray experimental: Data were collected at 173 K on a Siemens SMART PLATFORM equipped with A CCD area detector and a graphite monochromator utilizing MoK α radiation ($\lambda = 0.71073$ Å). Cell parameters were refined using up to 8192 reflections. A full sphere of data (1850 frames) was collected using the ω -scan method (0.3° frame width). The first 50 frames were re-measured at the end of data collection to monitor instrument and crystal stability (maximum correction on I was < 1 %). Absorption corrections by integration were applied based on measured indexed crystal faces.

The structure of **4k** was solved by the Direct Methods in *SHELXTL6*,¹ and refined using full-matrix least squares. The non-H atoms were treated anisotropically (except the carbon atoms of the methoxy and cyclopropyl moieties), whereas the hydrogen atoms were calculated in ideal positions and were riding on their respective carbon atoms. The molecules crystallize in the monoclinic space group P21 and display mirror pseudo-symmetry where the three ring system lies on this mirror. Thus the cyclopropyl and methoxy moieties are disordered and were refined in two parts. A total of 247 parameters were refined in the final cycle of refinement using 2188 reflections with $I > 2\sigma(I)$ to yield R_1 and wR_2 of 7.47% and 16.62%, respectively. Refinement was done using F^2 .

¹ SHELXTL6 (2000). Bruker-AXS, Madison, Wisconsin, USA.

View of the molecule showing part 1 only.

View of the molecule showing part 2 only. Atom C17' has the two F atoms disordered in three positions. One of them, F5' is removed for clarity.

Table S1. Crystal data and structure refinement for **4k**.

Identification code	xc04	
Empirical formula	C17 H12 F4 O	
Formula weight	308.27	
Temperature	173(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P2(1)	
Unit cell dimensions	a = 8.0436(9) Å	α = 90°.
	b = 5.7529(6) Å	β = 90.757(2)°.
	c = 15.4868(17) Å	γ = 90°.
Volume	716.57(13) Å ³	
Z	2	
Density (calculated)	1.429 Mg/m ³	
Absorption coefficient	0.123 mm ⁻¹	
F(000)	316	
Crystal size	0.26 x 0.20 x 0.04 mm ³	
Theta range for data collection	1.31 to 27.50°.	
Index ranges	-10 ≤ h ≤ 9, -7 ≤ k ≤ 7, -16 ≤ l ≤ 20	
Reflections collected	4550	
Independent reflections	2801 [R(int) = 0.0200]	
Completeness to theta = 27.50°	98.7 %	
Absorption correction	Integration	
Max. and min. transmission	0.9947 and 0.9642	
Refinement method	Full-matrix least-squares on F ²	
Data / restraints / parameters	2801 / 3 / 247	
Goodness-of-fit on F ²	1.014	
Final R indices [I > 2σ(I)]	R1 = 0.0581, wR2 = 0.1512 [2188]	
R indices (all data)	R1 = 0.0747, wR2 = 0.1662	
Absolute structure parameter	0.5(18)	
Largest diff. peak and hole	0.207 and -0.295 e.Å ⁻³	

$$R1 = \sum(|F_o| - |F_c|) / \sum|F_o|$$

$$wR2 = [\sum(w(F_o^2 - F_c^2)^2) / \sum(w(F_o^2)^2)]^{1/2}$$

$$S = [\sum(w(F_o^2 - F_c^2)^2) / (n-p)]^{1/2}$$

$$w = 1/[\sigma^2(F_o^2) + (m \cdot p)^2 + n \cdot p], p = [\max(F_o^2, 0) + 2 \cdot F_c^2] / 3, m \text{ \& } n \text{ are constants.}$$

Table S2. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **4k**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
C1	1396(3)	6872(5)	10240(2)	45(1)
C2	1898(3)	5511(5)	11035(2)	42(1)
C3	2783(3)	3488(4)	10792(2)	40(1)
C4	2904(3)	3469(4)	9851(2)	38(1)
C5	2102(3)	5440(5)	9512(2)	41(1)
C6	1592(4)	5951(5)	11888(2)	54(1)
C7	2178(5)	4422(6)	12514(2)	62(1)
C8	3059(4)	2434(6)	12275(2)	60(1)
C9	3361(3)	1977(5)	11424(2)	49(1)
C10	1983(3)	5782(5)	8631(2)	48(1)
C11	2673(4)	4169(6)	8080(2)	55(1)
C12	3481(4)	2192(6)	8407(2)	52(1)
C13	3609(3)	1848(5)	9292(2)	46(1)
C14	1878(6)	5003(7)	13435(3)	86(1)
O1	2398(9)	6894(9)	13751(3)	75(2)
C15	70(20)	4530(30)	13764(10)	96(2)
C16	1083(12)	3020(20)	14041(7)	96(2)
C17	4040(13)	6550(20)	14007(9)	96(2)
F1	-798(9)	6274(10)	14215(3)	108(3)
F2	-1190(30)	3190(30)	13301(11)	252(10)
F3	4140(12)	6530(30)	14820(5)	226(6)
F4	4920(14)	8370(20)	13822(7)	162(4)
O1'	471(10)	5754(19)	13727(5)	102(3)
C15'	3363(15)	6520(20)	14026(8)	79(2)
C16'	3247(11)	4135(16)	14234(6)	79(2)
C17'	-665(9)	4430(20)	13737(7)	79(2)
F1'	2867(11)	8208(11)	14530(4)	124(3)
F2'	4696(10)	7236(17)	13549(4)	107(3)
F3'	-1965(15)	5260(70)	14124(14)	228(16)
F4'	-710(40)	2600(70)	14335(12)	280(20)
F5'	-1323(7)	3938(15)	13129(4)	76(2)

Table S3. Bond lengths [Å] and angles [°] for **4k**.

C1-C2	1.508(4)
C1-C5	1.514(4)
C1-H1A	0.9900
C1-H1B	0.9900
C2-C6	1.372(4)
C2-C3	1.418(4)
C3-C9	1.384(4)
C3-C4	1.462(4)
C4-C13	1.397(4)
C4-C5	1.404(4)
C5-C10	1.380(4)
C6-C7	1.387(5)
C6-H6A	0.9500
C7-C8	1.398(5)
C7-C14	1.488(5)
C8-C9	1.370(4)
C8-H8A	0.9500
C9-H9A	0.9500
C10-C11	1.382(4)
C10-H10A	0.9500
C11-C12	1.401(5)
C11-H11A	0.9500
C12-C13	1.387(4)
C12-H12A	0.9500
C13-H13A	0.9500
C14-O1	1.262(7)
C14-O1'	1.298(9)
C14-C15	1.568(16)
C14-C16	1.614(12)
C14-C16'	1.719(10)
C14-C15'	1.731(13)
O1-C17	1.388(11)
C15-C16	1.259(17)
C15-F1	1.415(17)

C15-F2	1.45(2)
C16-H16A	0.9900
C16-H16B	0.9900
C17-F3	1.260(14)
C17-F4	1.300(16)
C17-H17A	1.0000
O1'-C17'	1.188(12)
C15'-F1'	1.311(12)
C15'-F2'	1.373(13)
C15'-C16'	1.413(16)
C16'-H16C	0.9900
C16'-H16D	0.9900
C17'-F5'	1.112(14)
C17'-F3'	1.303(18)
C17'-F4'	1.40(3)

C2-C1-C5	103.1(2)
C2-C1-H1A	111.1
C5-C1-H1A	111.1
C2-C1-H1B	111.1
C5-C1-H1B	111.1
H1A-C1-H1B	109.1
C6-C2-C3	120.3(3)
C6-C2-C1	129.8(3)
C3-C2-C1	109.9(2)
C9-C3-C2	119.5(3)
C9-C3-C4	132.4(2)
C2-C3-C4	108.1(2)
C13-C4-C5	119.7(3)
C13-C4-C3	130.9(2)
C5-C4-C3	109.3(2)
C10-C5-C4	120.7(2)
C10-C5-C1	129.6(3)
C4-C5-C1	109.6(2)
C2-C6-C7	119.5(3)
C2-C6-H6A	120.2

C7-C6-H6A	120.2
C6-C7-C8	120.2(3)
C6-C7-C14	118.0(3)
C8-C7-C14	121.8(3)
C9-C8-C7	120.6(3)
C9-C8-H8A	119.7
C7-C8-H8A	119.7
C8-C9-C3	119.9(3)
C8-C9-H9A	120.1
C3-C9-H9A	120.1
C5-C10-C11	119.4(3)
C5-C10-H10A	120.3
C11-C10-H10A	120.3
C10-C11-C12	120.7(3)
C10-C11-H11A	119.7
C12-C11-H11A	119.7
C13-C12-C11	120.1(3)
C13-C12-H12A	120.0
C11-C12-H12A	120.0
C12-C13-C4	119.4(3)
C12-C13-H13A	120.3
C4-C13-H13A	120.3
O1-C14-O1'	82.2(6)
O1-C14-C7	120.6(4)
O1'-C14-C7	124.2(5)
O1-C14-C15	109.1(7)
O1'-C14-C15	29.6(7)
C7-C14-C15	115.7(7)
O1-C14-C16	121.0(5)
O1'-C14-C16	71.2(6)
C7-C14-C16	118.0(5)
C15-C14-C16	46.6(6)
O1-C14-C16'	76.4(5)
O1'-C14-C16'	113.5(5)
C7-C14-C16'	121.0(4)
C15-C14-C16'	107.6(7)

C16-C14-C16'	68.4(5)
O1-C14-C15'	30.4(4)
O1'-C14-C15'	104.3(6)
C7-C14-C15'	120.0(5)
C15-C14-C15'	123.5(7)
C16-C14-C15'	109.0(6)
C16'-C14-C15'	48.4(5)
C14-O1-C17	107.2(6)
C16-C15-F1	129.9(13)
C16-C15-F2	104.3(15)
F1-C15-F2	105.8(14)
C16-C15-C14	68.6(9)
F1-C15-C14	120.2(11)
F2-C15-C14	125.0(13)
C15-C16-C14	64.8(9)
C15-C16-H16A	117.3
C14-C16-H16A	117.3
C15-C16-H16B	117.3
C14-C16-H16B	117.3
H16A-C16-H16B	114.3
F3-C17-F4	101.5(11)
F3-C17-O1	109.5(11)
F4-C17-O1	109.8(11)
F3-C17-H17A	111.8
F4-C17-H17A	111.8
O1-C17-H17A	111.8
C17'-O1'-C14	117.8(10)
F1'-C15'-F2'	110.1(10)
F1'-C15'-C16'	124.1(10)
F2'-C15'-C16'	117.9(10)
F1'-C15'-C14	118.4(9)
F2'-C15'-C14	113.9(8)
C16'-C15'-C14	65.4(6)
C15'-C16'-C14	66.2(7)
C15'-C16'-H16C	117.1
C14-C16'-H16C	117.1

C15'-C16'-H16D	117.1
C14-C16'-H16D	117.1
H16C-C16'-H16D	114.1
F5'-C17'-O1'	120.7(10)
F5'-C17'-F3'	96.2(11)
O1'-C17'-F3'	113.3(19)
F5'-C17'-F4'	110.5(13)
O1'-C17'-F4'	120.9(13)
F3'-C17'-F4'	87(2)

Symmetry transformations used to generate equivalent atoms:

Table S4. Anisotropic displacement parameters ($\text{\AA}^2 \times 10^3$) for **4k**. The anisotropic displacement factor exponent takes the form: $-2\pi^2 [h^2 a^{*2} U^{11} + \dots + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
C1	40(1)	30(1)	66(2)	0(1)	1(1)	4(1)
C2	36(1)	30(1)	59(2)	3(1)	7(1)	-1(1)
C3	30(1)	32(1)	58(2)	1(1)	1(1)	0(1)
C4	26(1)	31(1)	57(2)	-1(1)	2(1)	-3(1)
C5	30(1)	32(1)	61(2)	0(1)	1(1)	-4(1)
C6	59(2)	36(1)	67(2)	2(1)	14(1)	8(1)
C7	80(2)	45(2)	61(2)	0(2)	12(2)	5(2)
C8	76(2)	44(2)	60(2)	7(2)	-3(2)	8(2)
C9	48(1)	33(1)	65(2)	1(1)	0(1)	7(1)
C10	46(1)	40(1)	57(2)	10(1)	-5(1)	-2(1)
C11	55(2)	55(2)	55(2)	2(2)	-2(1)	-10(2)
C12	47(1)	51(2)	59(2)	-9(2)	6(1)	-5(1)
C13	34(1)	37(1)	68(2)	-1(1)	4(1)	1(1)
C14	132(4)	60(3)	66(2)	2(2)	28(2)	22(2)
O1	109(4)	50(3)	63(3)	-15(2)	-17(3)	7(3)
F1	163(6)	98(4)	64(3)	-23(3)	49(3)	20(4)
F2	370(20)	178(14)	207(14)	-22(11)	62(13)	-162(14)
F3	199(8)	379(18)	98(5)	44(8)	-62(5)	-13(12)
F4	145(7)	161(10)	179(9)	25(7)	-64(7)	-33(7)
O1'	102(5)	134(7)	72(4)	-1(5)	9(3)	11(6)
F1'	215(8)	82(4)	76(4)	-23(3)	0(4)	22(4)
F2'	90(4)	157(7)	76(4)	-11(4)	0(3)	-65(4)
F3'	55(6)	420(50)	208(19)	-120(30)	68(9)	-48(15)
F4'	330(40)	410(50)	93(10)	86(19)	-66(16)	-240(40)
F5'	86(3)	101(5)	40(2)	-12(3)	12(2)	-15(3)

Table S5. Hydrogen coordinates ($\times 10^4$) and isotropic displacement parameters ($\text{\AA}^2 \times 10^{-3}$) for **4k**.

	x	y	z	U(eq)
H1A	1884	8453	10252	54
H1B	172	6999	10188	54
H6A	983	7293	12050	64
H8A	3451	1390	12708	72
H9A	3967	627	11267	58
H10A	1432	7115	8405	57
H11A	2600	4402	7473	66
H12A	3941	1086	8023	62
H13A	4170	522	9517	56
H16A	988	1437	13798	116
H16B	1374	3068	14664	116
H17A	4514	5102	13749	116
H16C	2772	3736	14802	95
H16D	4180	3124	14060	95

General Experimental Methods

^1H , and ^{13}C NMR spectra were obtained at 300 MHz (^1H), 75 MHz (^{13}C) and 282 MHz (^{19}F) using CDCl_3 or acetone- d_6 as solvent, TMS as an internal reference standard for H and C and CFCl_3 as external reference for F. Toluene and benzene were distilled from sodium metal under nitrogen immediately before their use as solvents. $\text{FSO}_2\text{CF}_2\text{COOSiMe}_3$ (TFDA) was prepared according to the literature.^{1,2} Sodium fluoride (NaF) was dried in the oven before use. All other reagents and solvents were obtained from commercial sources and were used without additional purification.

- (1) Tian, F.; Kruger, V.; Bautista, O.; Duan, J.-X.; Li, A.-R.; Dolbier, W. R., Jr.; Chen, Q.-Y. *Org. Lett.* **2000**, 2, 563-564.
- (2) Dolbier, W. R., Jr.; Duan, J.-X.; Tian, F.; Chen, Q.-Y. *Org. Syn.* **2003**, 80, 172-176.