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Novel β-hydroxy-β-bis(trifluoromethyl) imines☆

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Abstract

Selected imines reacted with hexafluoroacetone non-catalyzed at ambient temperature to give β-hydroxy-β-bis(trifluoromethyl) imines in good to excellent yields. For the imines of acetone, pentan-3-one, and of cyclohexanone a 1:2 reaction was observed giving iminodiols; for *N*,*N*′-bis(propylidene)ethylene diamine an iminotetrol was formed. The diol derivative of *N*-isopropyl-propylidene amine could be deprotonated and *O*-methylated furnishing the respective ethers. Hexafluoropropylidene amine reacted with *N*-isopropyl-propylidene amine, unlike hexafluoroacetone, in a 1:1 manner to form an amino–imino alcohol which in its turn is able to add hexafluoroacetone. The imines of acetophenone, trifluoroacetone, 2,4-dimethyl-pentan-3-one, 2,6-dimethyl-cyclohexanone and of acetaldehyde added hexafluoroacetone to furnish β-iminoalcohols. A multifunctional β-hydroxy enaminone was obtained from 4-isopropylamino-pent-3-en-2-one. The molecular structures of the novel β-hydroxy-β-bis(trifluoromethyl) imines exhibit strong =(R)N···H−O− hydrogen bonds.

Keywords: β-Hydroxy-β-bis(trifluoromethyl) imines; Hexafluoroacetone; Ketimines; Aldimine

1. Introduction

Hexafluoroacetone and acetone furnish two products, namely 5,5,5-trifluoro-4-(trifluoromethyl)-4-hydroxy-2-pentanone (38%) and 1,1,1,7,7,7-heptafluoro-2,6-bis(trifluoromethyl)-2,6-dihydroxy-heptan-4-one (33%) taking 4 days at 135 °C or 20 h at 100 °C in an autoclave [1]. Template condensation products of 5,5,5-trifluoro-4-(trifluoromethyl)-4-hydroxy-2-pentanone with primary amines and diamines in the presence of metal cations, like Cu^{2+}, Ni^{2+}, Co^{2+} and Co^{3+} render in *one* step their respective complexes [2]. The free imino alcohol ligands have not been synthesized, so far. Recently, the reaction of hexafluoroacetone with an enamine, prepared from acetophenone and morpholine, gave the corresponding β-hydroxy-β-bis(trifluoromethyl) ketone in only 31% yield after hydrolysis [3]. Earlier, lithiated imines have been used and, e.g. hexafluoroacetone, to obtain β-hydroxy-β-bis(trifluoromethyl) ketones or the respective aldehyde after acidic workup [4a,b]. With selected imines, trifluoroacetone rendered β-hydroxy-β-trifluoromethyl imines or, after hydrolysis β-hydroxy-β-trifluoromethyl ketones [3,5]. Here we describe a simple and general new route to synthesize β-hydroxy-β-bis(trifluoromethyl) imines in good to excellent yield from various ketimines or aldimines and hexafluoroacetone *without* previous lithiation at ambient temperature.

2. Results and discussion

In an enamine mediated addition [5] the ketimines **1**, **4** [6], **11**, **12**, **16** [7] add two hexafluoroacetone (HFA) units per molecule, the ketimines **18**–**20**, **27**, **29**, the aldimine **21** and the enaminone **31** incorporate only one hexafluoroacetone (Schemes 1–5) to give colorless solid or liquid non-moisture sensitive β-hydroxy-β-bis(trifluoromethyl) imines **2**, **5**, **10**, **13**, **14**, **17**, **22**–**25**, **28**, **30** and **32** in good to excellent yields (Scheme 6).

N-Isopropyl-propylidene amine **1** and propylidene amine **4** reacted with HFA to give in 100 and 42% yield, respectively, the diols **2** (mp 92 °C) and **5** (106 °C); deprotonation

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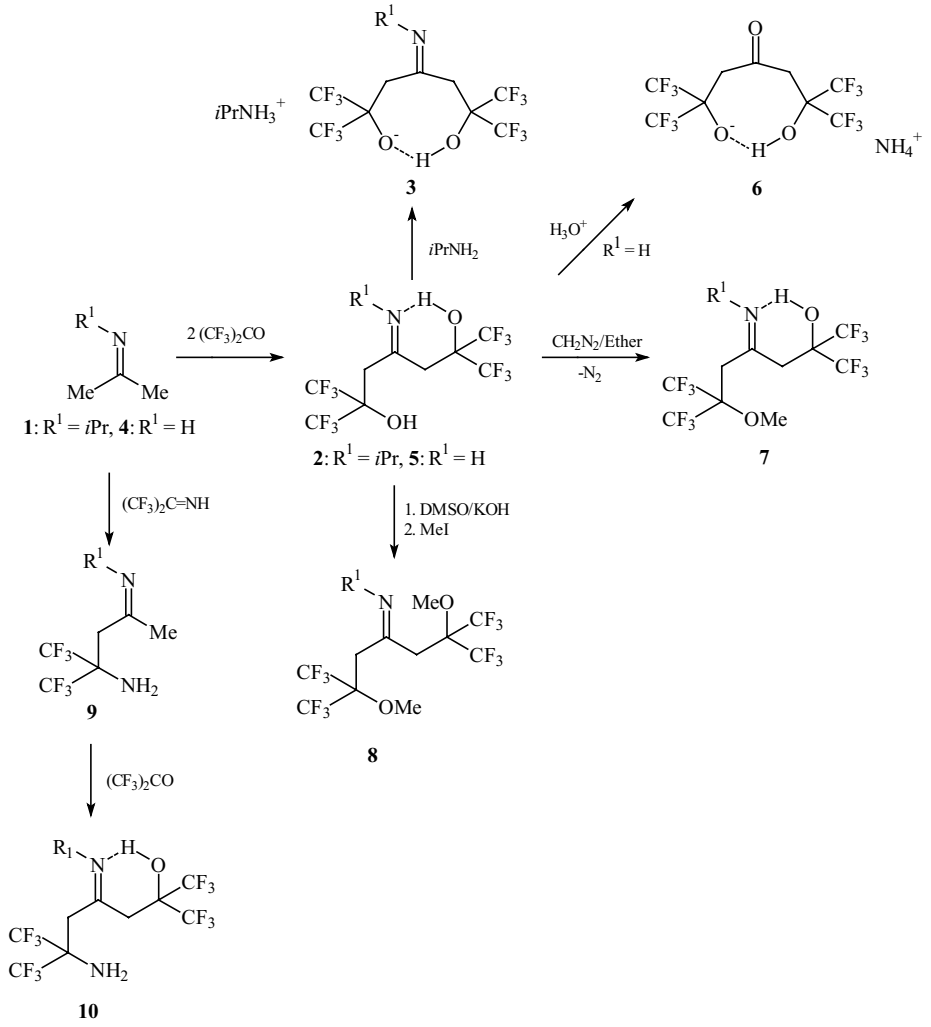
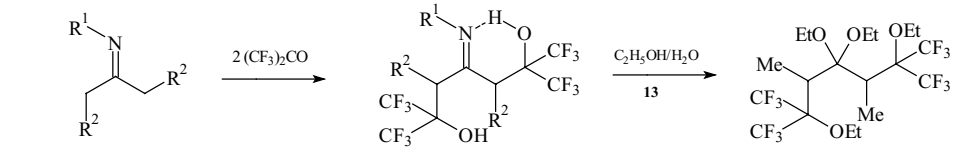
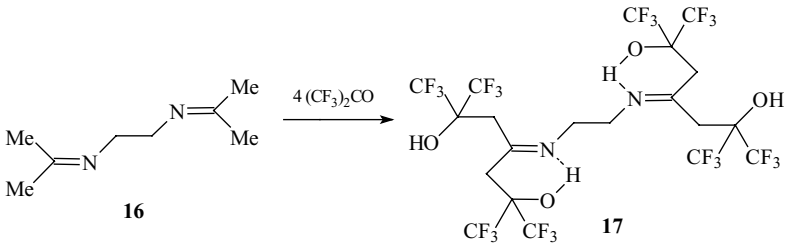


Scheme 1.

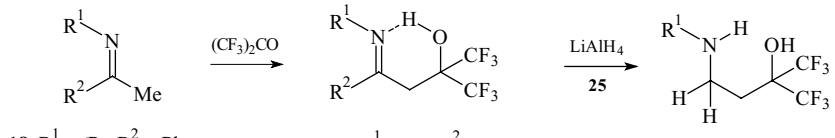
using isopropylamine afforded the respective monoalkoxide salt **3** (83%), acidic hydrolysis converts imine **5** into the keto monoalkoxide salt **6** (66%). In compound **2** obviously *one* hydroxy group bonds rather strong intramolecularly to the imino nitrogen donor. The second hydroxy moiety interacts intermolecularly with the oxygen function of the neighboring molecule (see later X-ray diffraction data discussion). Dissolved in polar solvents compound **2** could not be separated due to the strong hydrogen bond interaction with solvent molecules. Only mono methylation of **2** could be achieved using diazomethane to give the mono ether **7** (96%) because of the strong intramolecular hydrogen bonding OH···N═; dimethylation was successful under more drastic conditions applying KOH and MeI in DMSO to render diether **8** (15%). Reacting HFA imine [8] gave in 68% yield the imino amine **9**, a colorless liquid (bp 78 °C/25 Torr); a further addition was not observed under the conditions applied. Only HFA was able to insert into the CH bond of the remaining methyl group to yield compound **10** (85%, mp 34 °C) (Scheme 1).



Scheme 2.



Scheme 3.



18: R^1 = *i*Pr, R^2 = Ph
19: R^1 = *i*Pr, R^2 = CF_3
20: R^1 = *t*Bu, R^2 = Ph
21: R^1 = *i*Pr, R^2 = H

22: R^1 = *i*Pr, R^2 = Ph
23: R^1 = *i*Pr, R^2 = CF_3
24: R^1 = *t*Bu, R^2 = Ph
25: R^1 = *i*Pr, R^2 = H

Scheme 4.

The imines of pentanone-2, **11** and of cyclohexanone, **12** react with HFA to give the diols **13** (75%, mp 101 °C) and **14** (100%, mp 121 °C), containing each, two chiral centers. Surprisingly, ethanol furnishes an bis-ether hydrate **15** (48%, 75 °C/25 Torr) of the respective ketone (Scheme 2).

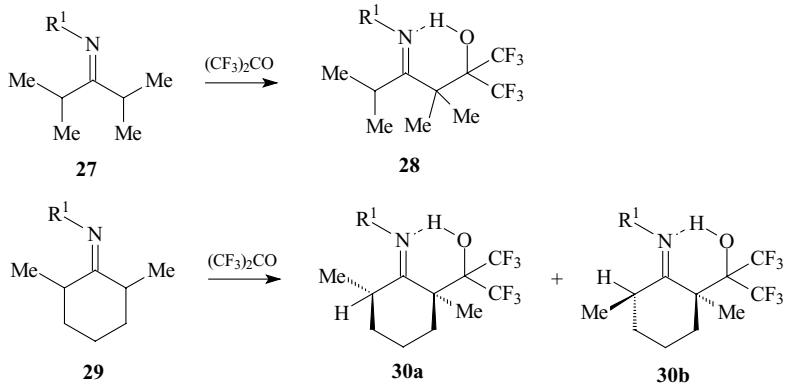
N,*N*′-Bis(propylidene)-ethylene-diamine **16** and HFA straightforwardly react in a 1:4 manner to furnish tetrol **17** (91%, mp 149 °C) (Scheme 3).

Allowing to interact the ketimines **18**–**20** possessing only one methyl group with HFA at room temperature resulted in the almost quantitative formation of the β-hydroxy imines **22**–**24**, colorless liquids. Changing the bulkiness of the *N*-alkyl moiety from *i*-Pr (**18**) to *t*-Bu (**20**) did not influence reaction rate and yield. The aldimine **21** undergoes the same ‘‘insertion’’ of hexafluoroacteone yielding compound **25** (98%, mp 64 °C), which is hydrogenated easily furnishing the liquid β-hydroxy amine **26** in moderate yield.

The ketimines **27** and **29** possessing two $CHMe_2$ or $CH(Me)CH_2$ functions probably for steric reasons react only with *one* molecule of HFA giving the β-hydroxy imines **28** (100%, mp 59 °C) and an oily 8:2 mixture of the two diastereomers **30a** and **30b**. In the case of **28** the steric influence of the *N*-isopropyl and the second *C*-isopropyl group prevents a further attack of hexafluoroacetone (see Fig. 9).

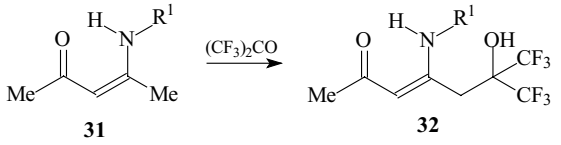
In the case of the enaminone **31** HFA ‘‘inserts’’ to yield the multifunctional β-hydroxy enaminone **32** (94%, mp 75 °C) (Scheme 6).

The molecular structure of compound **2** shows a considerably short intramolecular hydrogen bridge [9] between



R^1 = *i*Pr

Scheme 5.



Scheme 6.

the imino nitrogen N(1) and *one* HO(2) group featuring a O–H···N= distance of 255 pm. The angles between N(1), C(5), C(6), C(7), and O(2) vary in the range of 112° and 117°, assuming an almost planar six-membered ring system (Fig. 1). The C=N bond length was found to be 128.2 pm [10]. The second HO group bonds intermolecularly to an oxygen of a second molecule with a $-OH\cdots O(H)$ distance of 273 pm.

The geometry of **2** completely changed if one proton is removed to give compound **3**. There is now an intramolecular hydrogen bridge between $-O(1)^-\cdots HO(2)-$ (241.2 pm) forming an eight-membered ring. (Fig. 2). The C=N bond length was found to be 126.9 pm. The isopropylammonium ion shows no contacts to the anion.

In the unit cell of **6** three anions surround one NH_4^+ [NH(3)H(4)H(5)H(6)$^+$] cation allowing three intermolecular hydrogen bridges [9] to be formed $NH(3)\cdots O(1) = 271.0$ pm, $NH(5)\cdots O(2) = 273.6$ pm and $NH(6)\cdots O(3) = 284.3$ pm. The H(4)-atom of NH_4^+ shows no interaction. Obviously, the strong Coulomb interaction between anion and cation causes a dense packing resulting in a high density (1.808 mg m^{-3}) for an organic compound. Furthermore, there is a short intramolecular hydrogen bond (240.6 pm) $-O(1)^-\cdots HO(2)-$. The C(2)–O(1)$^-$ bond is slightly shorter (136.9 pm) than the C(7)–O(2)H bond (138.1 pm); the C(2)–C(4) and C(6)–C(7) bond lengths of 154 pm are markedly longer than C(4)–C(5) with 150 and

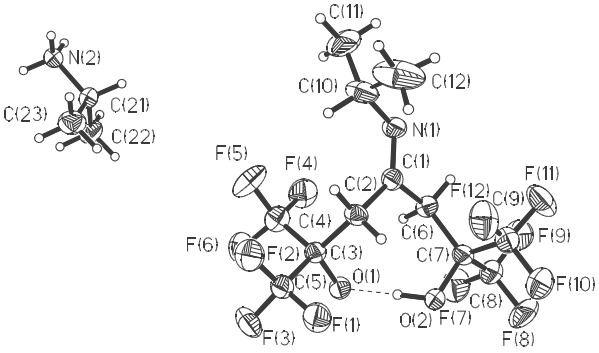


Fig. 2. Selected bond lengths (pm) and bond angles (°) for compound **3** (thermal elipsoids with 50% probability): C(1)–N(1) 126.9(3), C(1)–C(2) 152.5(4), C(3)–O(1) 137.8(3), C(2)–C(3) 154.5(4), C(7)–O(2) 137.1(3); O(1)–C(3)–C(2) 113.9(2), N(1)–C(1)–C(2) 126.2(3), C(1)–C(2)–C(3) 116.7(2), C(1)–N(1)–C(10) 122.4(3), N(1)–C(1)–C(6) 115.2(2), O(2)–C(7)–C(6) 114.2(2).

C(5)–C(6) with 151 pm, probably due to the electronic effect of the CF_3 groups and the oxygen. As in structure **3**, the intramolecular hydrogen bridge causes an eight-membered ring. The bond angles vary from 112.9° for O(2)–C(7)–C(6) and 122.0° for C(6)–C(5)–C(4) (Fig. 3).

The molecular structure of **7** (Fig. 4) shows one intramolecular hydrogen bridge $-OH\cdots N(R^1)=C = 262.5$ pm slightly longer than in compound **2**; C(10)–O(2) was found to be 139.4 pm, C(11)–O(2), however, 144.4 pm due to the −I effect of the neighboring CF_3 moieties. All carbon atoms, except C(5) are tetrahedrally coordinated with bond angles 117.0° for N(1)–C(5)–C(4), C(4)–C(5)–C(9) and 121.4° for C(10)–O(2)–C(11).

The molecular structure of **10** (Fig. 5) exhibits a strong intramolecular HO hydrogen bridge of 258.3 pm to the imino nitrogen, inducing an almost planar six-membered

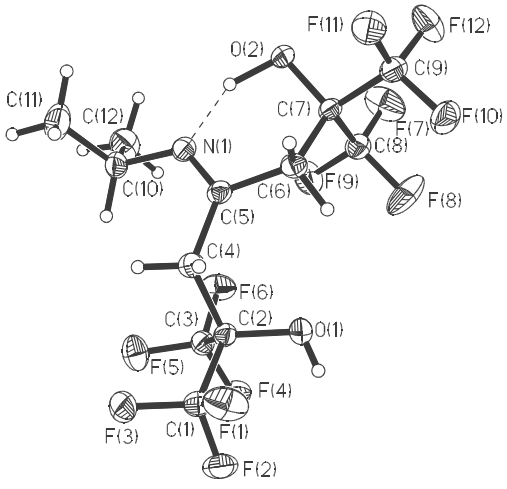


Fig. 1. Selected bond lengths (pm) and bond angles (°) for compound **2** (thermal elipsoids with 50% probability): C(2)–C(4) 153.8(3), C(2)–O(1) 139.2(3), C(4)–C(5) 151.9(3), C(5)–N(1) 128.2(3), C(7)–O(2) 140.8(3); O(1)–C(2)–C(4) 109.4(2), N(1)–C(5)–C(4) 126.4(3), C(4)–C(5)–C(6) 116.0(2), C(5)–N(1)–C(10) 124.8(2), N(1)–C(5)–C(6) 116.9(2), O(3)–C(5)–C(6) 120.1(3), O(2)–C(7)–C(6) 112.6(2).

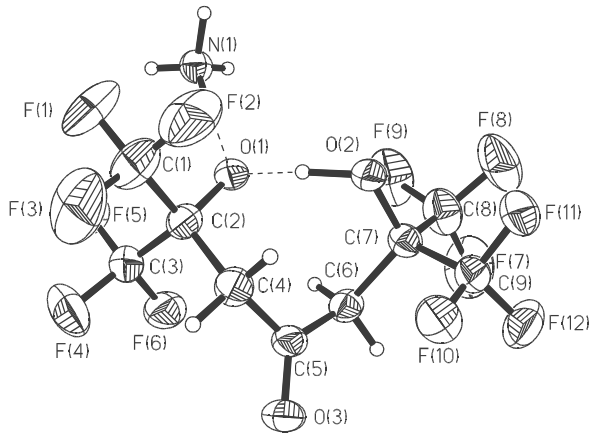


Fig. 3. Selected bond lengths (pm) and bond angles (°) for compound **6** (thermal elipsoids with 50% probability): C(1)–C(2) 153.8(4), C(2)–O(1) 136.9(3), C(2)–C(4) 154.5(4), C(6)–C(7) 154.1(4), C(4)–C(5) 151.2(4), C(5)–C(6) 150.2(4), C(5)–O(3) 121.6(3), C(7)–O(2) 138.1(3); O(1)–C(2)–C(4) 113.5(2), O(1)–C(2)–C(3) 107.4(2), O(2)–C(7)–C(6) 112.9(2), C(1)–C(2)–C(3) 110.2(3), O(3)–C(5)–C(6) 120.1(3), O(3)–C(5)–C(4) 117.9(3), C(4)–C(5)–C(6) 122.0(2), C(6)–C(5)–C(4) 122.0(2).

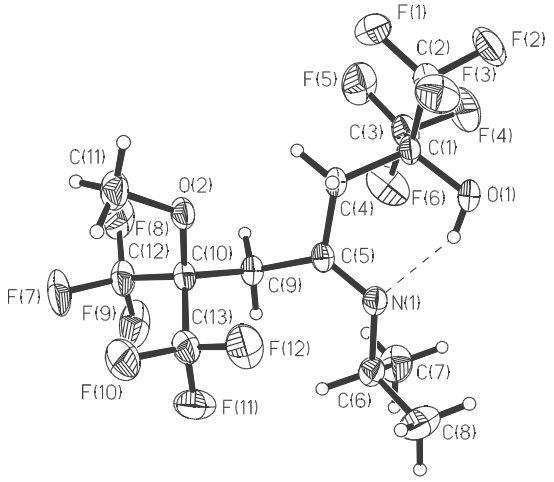


Fig. 4. Selected bond lengths (pm) and bond angles (°) for compound **7** (thermal elipsoids with 50% probability): O(1)–C(1) 139.22(18), C(1)–C(2) 153.5(2), C(4)–C(5) 151.9(2), C(5)–N(1) 127.01(19), N(1)–C(6) 147.0(2), C(10)–O(2) 139.36(18), C(11)–O(2) 144.37(18); O(1)–C(2)–C(2) 105.71(11), O(1)–C(1)–C(4) 113.99(12), N(1)–C(5)–C(4) 116.95(12), C(4)–C(5)–C(9) 117.41(12), C(10)–O(2)–C(11) 106.41(11), N(1)–C(5)–C(9) 125.95(13), C(5)–N(1)–C(6) 124.20(12), O(2)–C(10)–C(9) 121.35(12).

ring, whereas the NH_2 group shows no similar interaction. C(4)–N(1) with 127.4 pm, C(5)–C(6) 153.3 pm and C(9)–C(10) 154.7 pm are slightly longer than in the structures discussed above.

A short intramolecular hydrogen bond $O(2)H\cdots N(1) = 253.7$ pm was observed in compound **13** (Fig. 6), resulting in the formation of a planar six-membered ring with N(1)–C(6)–C(7) 114.2(2)°, C(6)–C(7)–C(9) 111.3(2)° and C(7)–C(9)–O(2) 112.1(2)°. The second HO group bridges intermolecularly to O(2) of a neighboring molecule with 267.6 pm. The absolute configuration of the chiral center at C(4) was determined to be *R*, at C(7) to be *S*.

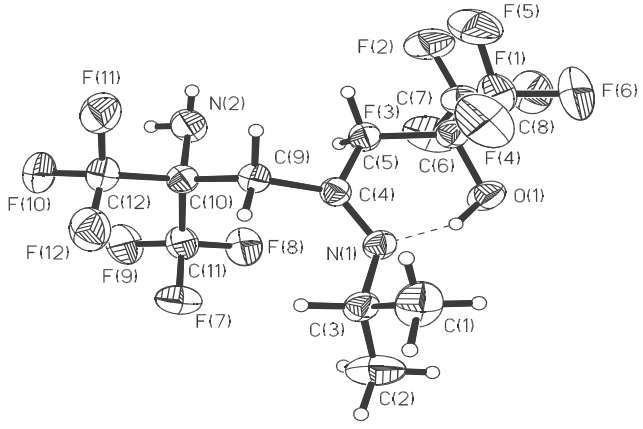


Fig. 5. Selected bond lengths (pm) and bond angles (°) for compound **10** (thermal elipsoids with 50% probability): O(1)–C(6) 139.6(3), C(5)–C(6) 153.3(3), C(4)–C(5) 152.2(3), C(4)–N(1) 127.4(3), N(1)–C(3) 147.0(3), C(10)–N(2) 145.0(3), C(9)–C(10) 154.7(3); O(1)–C(6)–C(5) 114.39(17), N(1)–C(4)–C(5) 118.02(18), N(2)–C(10)–C(9) 111.34(12), N(1)–C(4)–C(9) 125.97(19), C(4)–N(1)–C(3) 124.57(18).

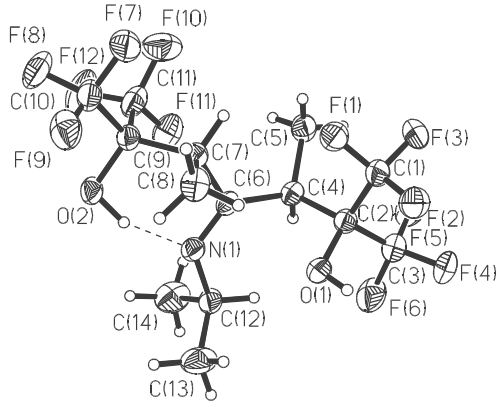


Fig. 6. Selected bond lengths (pm) and bond angles (°) for compound **13** (thermal elipsoids with 50% probability): O(1)–C(2) 139.4(3), C(4)–C(6) 153.4(4), C(6)–N(1) 126.7(3), N(1)–C(12) 147.4(3), C(7)–C(9) 156.7(4), C(9)–O(2) 139.4(3); O(1)–C(2)–C(4) 106.7(2), O(2)–C(9)–C(7) 112.1(2), N(1)–C(6)–C(4) 124.6(2), N(1)–C(6)–C(7) 114.2(2), C(4)–C(6)–C(7) 121.2(2), C(6)–N(1)–C(12) 126.7(2), C(6)–C(4)–C(5) 113.5(2), C(6)–C(7)–C(9) 111.3(2).

In compound **14** (Fig. 7) an intramolecular hydrogen bridge $O(2)H\cdots N(1)=C$ was found to be 253.9 pm, an intramolecular bridge $O(1)H\cdots O(2)$ to be 268.9 pm. The two chiral centers at C(2) and C(6) were determined as *R*. The cyclohexane ring is disordered in the crystal, showing chair and envelope conformation.

Surprisingly, in the aldimine derivative **26** (Fig. 8) the HO group forms no hydrogen bridge towards the imino nitrogen, but only an intermolecular bridge with 271.7 pm to the neighboring nitrogen.

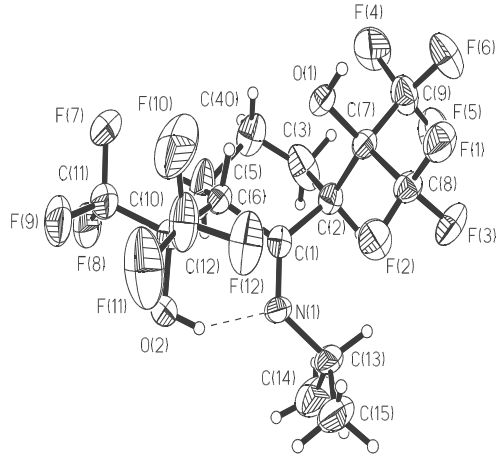


Fig. 7. Selected bond lengths (pm) and bond angles (°) for compound **14** (thermal elipsoids with 50% probability): C(1)–N(1) 126.4(5), C(1)–C(2) 153.8(6), N(1)–C(13) 147.1(5), C(40)–C(5) 164.9(9), O(1)–C(7) 139.1(5), C(10)–O(2) 139.8(5); O(1)–C(7)–C(2) 110.3(3), O(2)–C(10)–C(6) 113.3(1), N(1)–C(1)–C(2) 127.0(4), N(1)–C(1)–C(6) 117.9(4), C(2)–C(1)–C(6) 114.0(3), C(1)–N(1)–C(13) 125.9(4), C(1)–C(2)–C(7) 114.6(4). (The $C(40)H_2$ group in the six-membered ring is disordered with C(4) in chair C(40) and envelope C(41) position, equally weighted. For simplicity reasons, only the chair conformation was shown in the figure.)

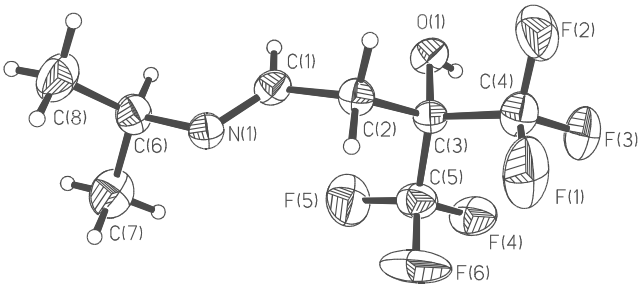


Fig. 8. Selected bond lengths (pm) and bond angles (°) for compound **26** (thermal elipsoids with 50% probability): O(1)–C(6) 139.6(3), C(5)–C(6) 153.3(3), C(4)–C(5) 152.2(3), C(4)–N(1) 127.4(3), N(1)–C(3) 147.0(3), C(10)–N(2) 145.0(3); O(1)–C(6)–C(5) 114.39(17), N(1)–C(4)–C(5) 118.02(18), N(2)–C(10)–C(9) 111.34(12), N(1)–C(4)–C(9) 125.97(19), C(4)–N(1)–C(3) 124.57(18).

The molecular structure of **28** shows a short intramolecular hydrogen bridge $O(1)H\cdots N(1) = 253.1$ pm forming an almost planar six-membered ring O(1)–H(1)–N(1)–C(7)–C(4)–C(2) containing angles between 110.9(3)° and 114.7(3)° (Fig. 9).

The ^{1}H, ^{19}F and ^{13}C NMR data confirm the proposed structures of the new compounds. The two sets of the four CF_3 groups in **2** and **3** (*syn* and *anti* with respect to the isopropyl moiety) are magnetically not equivalent resulting in two signals each in the ^{19}F NMR spectra. Complementary, their ^{1}H and ^{13}C NMR spectra exhibit two resonances for *syn*- and *anti*-orientated CH_2 groups. Having a center of chirality in the two α-positions of compounds **13** and **14** the vicinal CF_3 groups are magnetically non-equivalent resulting in a quartet splitting. Since the *syn*- and *anti*-positions are also different, four signals are observed, but no indication of two diastereomers being present; probably a loss of stereoinformation due to the imine/enamine tautomeric equilibria takes place causing the formation of one favored isomer. In the case of **13**, in the ^{19}F NMR spectrum four quartets ($^{4}J_{FF} = 10.3$ Hz) are observed. In compound **14** the number of possible isomers is even larger, since, besides the two chiral centers different conformations of the cyclohexane ring could be envisaged. Therefore in the ^{19}F NMR spectrum/CD_3CN) only multiplets are observed from overlapping quartets of the divers isomers. In the acetal **15** at $\delta_H = 3.1$ a quartet for the protons at the chiral centers at C(3) and C(5) is observed, at $\delta_H = 2.6$ a second order ABM_3 resonance for the methylene protons of the ethyl groups. The methyl moieties at the chiral carbon split into a doublet at 1.3 ppm, the ethyl groups due the non-equivalence of the methylene protons into a overlapping doublet of doublets, resulting in a triplet centered at $\delta_H = 1.0$. In the ^{19}F NMR spectrum the CF_3 groups are, as expected, magnetically non-equivalent and split into a quartet each. Compound **30** possesses two chiral centers with two possible diastereomers **30a** and **b**. In the ^{19}F NMR spectrum two quartets each are observed, at −69.4/−73.7 ppm ($^{4}J_{FF} = 10.1$ Hz) and at −72.5/−73.4 ppm, respectively, in a 80:20 ratio.

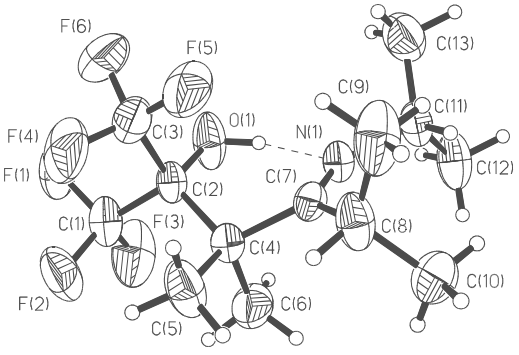


Fig. 9. Selected bond lengths (pm) and bond angles (°) for compound **28** (thermal elipsoids with 50% probability): O(1)–C(2) 138.3(4), C(2)–C(4) 157.8(4), C(4)–C(5) 152.4(5), C(4)–C(7) 156.0(4), C(7)–N(1) 126.7(4), N(1)–C(11) 147.0(4); O(1)–C(2)–C(4) 113.7(3), N(1)–C(7)–C(8) 118.02(18), C(8)–C(7)–C(4) 118.9(3), N(1)–C(7)–C(8) 126.0(3), C(7)–N(1)–C(11) 126.6(3).

3. Conclusion

In a straightforward enamine mediated C–C bond formation hexafluoroacetone adds to some ketimines and one aldimine to furnish the respective β-imino alcohols precursors for fluorinated β-amino alcohols and β-hydroxy ketones (shown in one case each) being versatile synthons for bioactive compounds. Further studies are in progress.

4. Experimental

NMR spectra were obtained on a Bruker AC 80 instrument operating at 75.39 MHz (^{19}F, internal standard CCl_3F) and a Bruker DPX-200 spectrometer operating at 200.13 MHz for ^{1}H (TMS), 188.31 MHz for ^{19}F ($CFCl_3$) and 50.32 MHz ^{13}C (TMS). MS spectra were obtained on a Varian MAT CH7A instrument at 70 eV. All reactions and manipulations were conducted under atmosphere of dry nitrogen.

The ketimines **1** [11], **4** [6], **11** [12], **12** [13], **16** [7], **18** [14], **20** [15], **27** [14], **29** [14], and the aldimine **21** [16] have been prepared according to the literature procedures.

4.1. 1,1,1,7,7,7-Hexafluoro-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-isopropylimino-heptane (2)

To 1.10 g (11 mmol) **1** 7.25 g (44 mmol) HFA was added at −196 °C and the mixture warmed up to ambient temperature. From the white solid excess of HFA was pumped off in vacuo; mp 92 °C, yield 4.7 g (100%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.10 (CH_3 *i*-Pr, 6H, d, $^{3}J_{HH} = 6.2$ Hz), 2.80 (CH_2, 4H), 3.76 (CH *i*-Pr, 1H, sep, $^{3}J_{HH} = 6.2$ Hz), 6.20 (OH, 1H, s, broad); ^{19}F NMR ($CDCl_3$), δ (ppm): −85.65 (*anti*-CF_3, s), −81.90 (*syn*-CF_3, s). MS (EI), *m/e* (%): 431 (M^+, 7), 430 ($M^+ - H$, 15), 416 ($M^+ - CH_3$, 69), 362 ($M^+ - CF_3$, 52), 320 ($M^+ - CF_3$–*i*-Pr, 17), 250

($M^+ - 2CF_3$–*i*-Pr–H, 56), 208 ($M^+ - 3CF_3$–CH_3–H, 100), 69 (CF_3^+, 14), 43 (*i*-Pr^+, 75). Analysis: $C_{12}H_{13}F_{12}NO_2$ (MG 431.22), Calcd.: C 33.4, H 3.0, F 52.9; Found: C 33.6, H 3.2, F 52.7.

4.2. Isopropylammonium 1,1,1,7,7,7-hexafluoro-2-hydroxy-2,6-bis(trifluoromethyl)-4-isopropylimino-heptyl-6-ate (3)

To compound **2** (0.90 g, 2 mmol) in 5 ml THF 4 mmol isopropylamine was added, heated under reflux for 2 h and pumped off all volatiles. The remaining crystals were dried in vacuo; mp: 92 °C, yield 0.81 g (83%): ^{1}H NMR ($CDCl_3$), δ (ppm): 1.12 (CH_3 *i*-PrN=, 6H, d, $^3J_{HH} = 6.2$ Hz), 1.14 (CH_3 *i*$PrNH_3^+$, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.80 (*syn*-CH_2, 2H), 2.95 (*anti*-CH_2, 2H), 3.10 (CH *i*-PrN, 1H, sep, $^3J_{HH} = 6.2$ Hz), 3.30 (CH *i*$PrNH_3^+$, 1H, sep, $^3J_{HH} = 6.2$ Hz), 6.00 (OH and *i*$PrNH_3^+$, 4H, s, broad); ^{19}F NMR ($CDCl_3$), δ (ppm): −85.65 (*anti*-CF_3, s), −81.90 (*syn*-CF_3, s). ^{13}C NMR ($CDCl_3$), δ (ppm): 22.9 (CH_3 *i*-PrN, s), 24.5 (CH_3 *i*$PrNH_3^+$, s), 31.6 (*syn*-CH_2, s), 33.8 (*anti*-CH_2, s), 42.8 (CH *i*-PrN, s), 51.1 (*i*$PrNH_3^+$, s), 75.8 (*syn*-$C(CF_3)_2$, $^2J_{CF} = 15.4$ Hz, sep), 76.6 (*anti*-$C(CF_3)_2$ $^2J_{CF} = 15.4$ Hz, sep), 121.5 (*syn*-CF_3, $^1J_{CF} = 290$ Hz, q), 123.2 (*anti*-CF_3, $^1J_{CF} = 290$ Hz, q), 161.6 (C=N, s). MS (FAB, matrix: NBA), *m/e* (%), FAB negative: 430 (M^+, 100), 360 ($M^+ - CF_3$–H, 3), 264 ($M^+ - (CF_3)_2C{=}O$, 29), 194 ($M^+ - CF_3$–H–$(CF_3)_2C{=}O$, 19); FAB positive: 432 (M^+, 100), 362 ($M^+ - CF_3$–H, 15), 320 ($M^+ - CF_3$–*i*-Pr, 10), 250 ($M^+ - 2CF_3$–*i*-Pr–H, 22), 208 ($M^+ - 3CF_3$–CH_3–H, 25) and other fragments. Analysis: $C_{15}H_{22}F_{12}N_2O_2$ (MG 490.33), Calcd.: C 36.7, H 4.5, F 46.5; Found: C 36.6, H 4.5, F 44.6.

4.3. 1,1,1,7,7,7-Hexafluoro-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-imino-heptane (5)

To 0.80 g (15 mmol) **4** in 15 ml diethyl ether 7.50 g (45 mmol) HFA was added at −196 °C After warming to ambient temperature the solvent was pumped off and the remaining white solid sublimed; mp 106 °C, yield 2.50 g (42%). ^{1}H NMR ($CDCl_3$), δ (ppm): 2.9 (CH_2, 4H, s), 3.2 (OH, 2H, s); ^{19}F NMR ($CDCl_3$), δ (ppm): −74.4 (*anti*-CF_3, s), −75.3 (*syn*-CF_3, s). MS, *m/e* (%): 389 (M^+, 8), 370 ($M^+ - F$, 12), 250 ($M^+ - 2CF_3$, 34), 208 ($M^+ - HOC(CF_3)_2CH_2$, 64), 69 (CF_3^+, 100) and other fragments. Analysis: $C_9H_7F_{12}NO_2$ (MG 389.14), Calcd.: C 27.8, H 1.8, F 58.6; Found: C 27.0, H 2.1, F 56.7.

4.4. Ammonium-2,6-bis(trifluoromethyl)-1,1,1,7,7,7-hexafluoro-2-hydroxy-heptyl-4-on-6-ate (6)

To 3.9 g (10 mmol) **2** in 20 ml acetone 2 ml 5% HCl were added. The solution was kept at 50 °C for 2 h and then pumped off all volatiles in vacuo. The white solid was re-crystallized from *n*-hexane/THF (2:1) and sublimed; mp 78 °C, yield 2.70 g (66%). ^{1}H NMR (CD_3CN), δ (ppm): 3.1 ($CH_2C(CF_3)_2CO^-$, 2H, s), 3.2 ($CH_2C(CF_3)_2COH$, 2H, s), 4.4 (OH, NH_4^+, 5H, s). ^{19}F NMR (CD_3CN), δ (ppm): −81.9 ($(CF_3)_2COH$, 6F, s), −82.1 ($(CF_3)_2CO^-$, 6F, s). MS (FAB, matrix: NBA), *m/e* (%), FAB positive: 407 (M^+, 11), 390 ($M^+ - NH_3$, 55), 154 ($M^+ - CF_3$, –$(CF_3)_2CO$, 100) and other fragments; FAB negative: 406 ($M^+ - H$, 44), 389 ($M^+ - NH_4$, 100), 223 ($M^+ - (CF_3)_2CO$, 50) and other fragments. Analysis: $C_9H_9F_{12}NO_3$ (MG 407.16), Calcd.: C 26.55, H 2.2, F 56.0; Found: C 27.0, H 2.1, F 55.3.

4.5. 1,1,1,7,7,7-Hexafluoro-2-hydroxy-2,6-bis(trifluoromethyl)-4-isopropylimino-6-methoxy-heptane (7)

To 2.20 g (5 mmol) **2** in 10 ml diethyl ether 60 ml 0.2 M (12 mmol) diazomethane solution was added at 0 °C within 30 min and stirred for 1 h. The excess of diazomethane was distilled off together with the solvent. The remaining yellowish solid was re-crystallized from petrol ether; mp 40 °C, yield 2.13 g (96%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.10 (CH_3 *i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.75 (CH_2, 2H), 2.79 (CH_2, 2H), 3.66 (OCH_3), 3.74 (CH *i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 9.40 (OH, 1H, s, broad); ^{19}F NMR ($CDCl_3$), δ (ppm): −75.40 (CF_3, s), −82.20 (CF_3, s). MS (EI), *m/e* (%): 445 (M^+, 3), 430 ($M^+ - CH_3$, 100), 415 ($M^+ - 2CH_3$, 17), 376 ($M^+ - CF_3$, 36), 334 ($M^+ - CF_3$–*i*-Pr, 15), 264 ($M^+ - 2CF_3$–*i*-Pr, 14), 208 ($M^+ - 3CF_3$–$2CH_3$, 56). Analysis: $C_{13}H_{15}F_{12}NO_2$ (MG 445.25), Calcd.: C 35.05, H 3.4, F 51.2; Found: C 35.2, H 3.5, F 51.1.

4.6. 2,6-Bistrifluoromethyl-2,6-dimethoxy-4-isopropylimino-1,1,1,7,7,7-hexafluoro-heptane (8)

In 10 ml DMSO 5.4 g (100 mmol) KOH were dissolved, 5.10 g (12 mmol) **2** in 10 ml DMSO added. The mixture was cooled to 0 °C, 7.0 g (48 mmol) methyl iodide added slowly and stirred for 1 h. The solution was treated three times with 20 ml dichloromethane, dried over $MgSO_4$ and distilled in vacuo, obtaining a yellow oil; mp 54 °C (10^{-2} hPa), yield 0.80 g (15%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.0 (*i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.5 (CH_2, 4H, s), 2.9 (*i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 3.6 (OCH_3, 6H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −75.2 (*anti*-CF_3, 6F, s), −75.5 (*syn*-CF_3, 6F, s). MS, *m/e* (%): 459 (M^+, 10), 444 ($M^+ - CH_3$, 42), 428 ($M^+ - OCH_3$, 16), 390 ($M^+ - CF_3$, 37), 348 ($M^+ - CF_3$, –*i*-Pr, 13), 222 ($HNCCH_2C(CF_3)_2OCH_3^+$, 100) and other fragments. HRMS (for $C_{14}H_{17}F_{12}NO_2$): Calcd.: 459.10678; Found: 459.10680.

4.7. 1,1,1-Trifluoro-2-trifluoromethyl-2-amino-4-isopropylimino-pentane (9)

To 1.10 g (11 mmol) **1** 7.54 g (46 mmol) hexafluoroacetone imine was added at −196 °C. The mixture was allowed to warm up to ambient temperature. The excess of hexa-

fluoroacetone imine was distilled off. The remaining colorless liquid was distilled using a Vigreux column; bp 78 °C (25 hPa), yield 1.63 g (68%). ^{1}H NMR, δ (ppm): 0.99 (CH_3 *i*-Pr $^2J_{HH} = 6.2$ Hz, d), 1.81 (CH_3, s), 2.55 (CH_2, s), 2.86 (NH_2, s[a]), 3.52 (CH *i*-Pr $^2J_{HH} = 6.2$ Hz, sep); ^{19}F, δ (ppm): −80.4 (CF_3, s), −83.9 (CF_3, s). MS (EI), *m/e* (%): 264 (M^+, 30), 263 ($M^+ - H$, 45), 207 ($M^+ - (CH_3)_2C{=}NH$, 42), 195 ($M^+ - CF_3$, 7), 165 ($(CF_3)_2NH^+$, 10), 42 (C_3H_6, 100). Analysis: $C_9H_{14}F_6N_2$ (MG 264.21), Calcd.: C 40.9, H 5.3, F 43.2; Found: C 40.0, H 5.3, F 43.5.

4.8. 2-Amino-1,1,1,7,7,7-hexafluoro-6-hydroxy-2,6-bis(trifluoromethyl)-4-isopropylimino-heptane (**10**)

To 2.7 g (10 mmol) **9** 2.0 g (12 mmol) HFA was added at −196 °C. The mixture was allowed to warm up to ambient temperature. The colorless liquid was dissolved in petrol ether and kept for 12 h at −20 °C. White crystal were obtained; mp 34 °C, 3.70 g (85%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.19 (d, 6H, CH_3, $^3J_{HH} = 6.2$ Hz), 1.75 (NH_2, 2H, s (broad)), 2.74 (*syn*-CH_2, 2H, s), 2.83 (*anti*-CH_2, 2H), 3.79 (CH, 1H, sep, $^3J_{HH} = 6.2$ Hz). ^{19}F NMR ($CDCl_3$), δ (ppm): −80.9 (*anti*-CF_3, 6F, s), −82.0 (*syn*-CF_3, 6F, s). MS, *m/e* (%): 430 (M^+, 2), 429 ($M^+ - H$, 3), 415 ($M^+ - CH_3$, 7), 361 ($M^+ - CF_3$, 25), 319 ($M^+ - CF_3$, –CH_3, 6), 264 ($M^+ - (CF_3)_2CO$, 100), 250 ($M^+ - 2CF_3$, –*i*-Pr, 17), 208 ($M^+ - 3CF_3$, –CH_3, 42) and other fragments. HRMS: for $C_{11}H_{14}F_9N_2O$ (M^+ without one CF_3 fragment): Calcd.: 361.09625; Found: 361.09729.

4.9. 1,1,1,7,7,7-Hexafluoro-3,5-dimethyl-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-isopropylimino-heptane (**14**)

To 2.50 g (20 mmol) **11** in 10 ml diethyl ether 6.70 g (40 mmol) HFA were added at −196 °C. The reaction mixture allowed to warm up to ambient temperature. After pumping off all volatiles a pure white solid was obtained; mp 101 °C, 6.60 g (75%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.0 (CH_3, 6H, d, $^3J_{HH} = 4.5$ Hz), 1.1 (CH_3 *i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 1.8 (CH, 2H, q, $^3J_{HH} = 4.5$ Hz), 3.8 (CH *i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 10.2 (OH, 2H, s); ^{19}F NMR (CD_3CN), δ (ppm): −70.1 (CF_3, 3F, q, $^4J_{FF} = 10.5$ Hz), −71.5 (CF_3, 3F, q, $^4J_{FF} = 10.5$ Hz), −72.6 (CF_3, 3F, q, $^4J_{FF} = 10.5$ Hz), −74.9 (CF_3, 3F, q, $^4J_{FF} = 10.5$ Hz). MS, *m/e* (%): 444 ($M^+ - CH_3$, 7), 390 ($M^+ - CF_3$, 8), 264 ($M^+ - 2CH_3$, –CF_3, –*i*-Pr, 30), 222 ($M^+ - CF_3H$, –$(CF_3)_2CO$, 100) and other fragments. Analysis: $C_{14}H_{17}F_{12}NO_2$ (MG 459.28), Calcd.: C 36.6, H 3.7, F 49.6; Found: C 36.45, H 3.7, F 49.6.

4.10. 1-Isopropylimino-2,6-bis(perfluoroisopropanol)-cyclohexane (**14**)

To 2.8 g (20 mmol) **12** in 20 ml diethyl ether 6.70 g (40 mmol) HFA was added at −196 °C and the mixture allowed to warm up to ambient temperature. All volatiles were pumped off in vacuo and quantitatively **14** was obtained as a white solid; mp 121 °C, 9.4 g (100%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.15 (*i*-Pr, 6H, d; $^3J_{HH} = 6.2$ Hz), 1.50–2.94 (CH_2, 6H, m), 3.52 (CH, 2H, m), 3.78 (*i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz). ^{19}F NMR ($CDCl_3$), δ (ppm): −76.7 (*anti*-CF_3, 6F, m), −80.1 (*syn*-CF_3, 6F, m). ^{13}C NMR (DMSO), δ (ppm): 20.2 (CH_3, s), 26.5 (C_4, s), 29.4 ($C_{3,5}$, s), 41.2 ($C_{2,6}$, s), 47.8 (CH, s), 90.7 ($C(CF_3)_2$, sep, $^2J_{CF} = 31.7$ Hz), 121.5 (CF_3, q, $^1J_{CF} = 290.5$ Hz), 176.5 (CN, s). MS, *m/e* (%): 471 (M^+, 28), 402 ($M^+ - CF_3$, 24), 360 ($M^+ - CF_3$, –*i*-Pr, 36), 220 ($M^+ - CF_3$, –CH_3, –$(CF_3)_2CO$, 39), 43 (*i*-Pr^+, 100) and other fragments. Analysis: $C_{15}H_{17}F_{12}NO_2$ (MG 471.29), Calcd.: C 38.2, H 3.6, F 48.4; Found: C 38.6, H 3.9, F 47.7.

4.11. 2,6-Diethoxy-2,6-bis(trifluoromethyl)-3,5-dimethyl-1,1,1,7,7,7-hexafluoro-heptan-4,4-diol (**15**)

To 4.3 g (9.4 mmol) **13** 20 ml of ethanol/water (3:1) were added and heated under reflux for 1 h, then three times washed with 20 ml chloroform and the organic phase dried over Na_2SO_4. The solvent was removed and the remaining liquid distilled; bp 75 °C (25 hPa), yield 2.20 g (48%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.0 (CH_3CH_2, 6H, t, $^3J_{HH} = 7.3$ Hz), 1.3 (CH_3, 6H, d, $^3J_{HH} = 7.0$ Hz), 2.6 (CH_3CH_2, 4H, q, $^3J_{HH} = 7.3$ Hz), 3.1 (CH, 2H, q, $^3J_{HH} = 7.0$ Hz), 6.4 (OH, 2H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −77.7 (CF_3, 6F, q, $^4J_{FF} = 10.6$ Hz), −79.9 (CF_3, 6F, q, $^4J_{FF} = 10.6$ Hz). MS, *m/e* (%): 223 (M^+−CH3CHC$(CF_3)_2OC_2H_5$, 19), 175 (M^+ − CH3CHC-$(CF_3)_2OC_2H_5$, –C_2H_5CO, 14), 57 ($C_2H_5CO^+$, 100) and other fragments. Analysis: $C_{15}H_{20}F_{12}O_4$ (MG 492.30), Calcd.: C 36.6, H 4.1, F 46.3; Found: C 38.3, H 4.1, F 45.7.

4.12. Ethylene-bis[1,1,1,7,7,7-hexafluoro-2,6-dihydroxy-2,6-bis(trifluoromethyl)-4-imino-heptane] (**17**)

To 2.10 g (15 mmol) **16** in 10 ml diethyl ether 10.00 g (60 mmol) HFA were added at −196 °C and allowed to warm up to ambient temperature. After pumping off all volatiles a white solid was obtained, which was re-crystallized from petroleum ether/acetone 3:1; mp 149 °C, yield 11.0 g (91%). ^{1}H NMR (CD_3CN), δ (ppm): 2.98 (CH_2, 8H, s), 3.69 (NCH_2, 4H, s), 7.16 (OH, 4H, s). ^{19}F NMR (DMSO), δ (ppm): −75.4 (*anti*-CF_3, 12F, s), −76.6 (*syn*-CF_3, 12F, s). MS, *m/e* (%): 735 ($M^+ - CF_3$, 10), 638 ($M^+ - (CF_3)_2CO$, 11), 402 ($M^+/2$, 100), 236 ($M^+/2$ –$(CF_3)_2CO$, 55) and other fragments. Analysis: $C_{20}H_{16}F_{24}N_2O_4$ (MG 804.32), Calcd.: C 29.9, H 2.0, F 56.7; Found: C 30.5, H 2.1, F 56.4.

4.13. 2-Isopropylimino-1,1,1-trifluoropropane (**19**)

To a mixture of trifluoroacetone (5.6 g, 50 mmol) and 9.0 g (150 mmol) isopropylamine in 20 ml diethyl ether 4.8 g (25 mmol) titanium tetrachloride in 20 ml *n*-pentane was added at 0 °C. The mixture was allowed to warm up to

ambient temperature and refluxed for 1 h. The precipitate was filtered off and washed with diethyl ether. The solvents were pumped off and the residue distilled; bp 82 °C, 6.5 g (85%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.0 (*i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 1.9 (CH_3, 3H, s), 3.5 (*i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz). ^{19}F NMR ($CDCl_3$), δ (ppm): −79.4 (CF_3, s). MS, *m/e* (%): 153 (M^+, 8), 138 ($M^+ - CH_3$, 61), 84 ($M^+ - CF_3$, 39), 42 ($C_3H_6^+$, 100) and other fragments. HRMS: for $C_5H_7F_3NO$ (molecular ion without one CH_3): Calcd.: 138.05305; Found: 138.05302.

4.14. 1-Isopropylimino-1-phenyl-3-trifluoromethyl-4,4,4-trifluorobutan-3-ol (**22**)

To 3.2 g (20 mmol) **18** in 20 ml diethyl ether 3.4 g (20 mmol) HFA was added. After 30 min all volatiles were pumped off and a pure colorless viscous liquid remains; yield 6.50 g (99%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (*i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.9 (CH_2, 2H, s), 3.6 (*i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 7.3 (aromatic H, 5H, m), 10.4 (OH, 1H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −82.1 (CF_3, s). MS, *m/e* (%): 327 (M^+, 14), 312 ($M^+ - CH_3$, 21), 258 ($M^+ - CF_3$, 24), 216 ($M^+ - CF_3$, –CH_3, 12), 104 ($M^+ - HOC(CF_3)_2CH_2$, –*i*-Pr, 100) and other fragments. Analysis: $C_{14}H_{15}F_6NO$ (MG 327.27), Calcd.: C 51.4, H 4.6, F 34.8; Found: C 52.0, H 4.9, F 34.6.

4.15. 1-Isopropylimino-1-trifluoromethyl-3-trifluoromethyl-4,4,4-trifluorobutan-3-ol (**23**)

To 2.3 g (15 mmol) **19** in 10 ml diethyl ether 2.5 g (15 mmol) HFA was added at −196 °C. All volatiles were pumped off in vacuo after warming up to ambient temperature. A pure colorless liquid was obtained; yield 4.7 g (98%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.2 (*i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.9 (CH_2, 2H, s), 4.1 (*i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 7.5 (OH, 1H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −70.5 (CF_3, 3F, s), −82.3 ($C(CF_3)_2$, 6F, s). MS, *m/e* (%): 319 (M^+, 8), 304 ($M^+ - CH_3$, 57), 250 ($M^+ - CF_3$, 60), 208 ($M^+ - CF_3$, –*i*-Pr, 100) and other fragments. Analysis: $C_9H_{10}F_9NO$ (MG 319.17), Calcd.: C 33.9, H 3.2, F 53.6; Found: C 33.8, H 3.3, F 53.4.

4.16. 1-Tert-butylimino-1,3-bis(trifluoromethyl)-4,4,4-trifluorobutan-3-ol (**24**)

To 1.8 g (10 mmol) **20** in 20 ml diethyl ether 1.7 g (10 mmol) HFA was added. After 30 min all volatiles were pumped off to give a colorless liquid in quantitative yield (3.50 g). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (CH_3, 9H, s), 2.9 (CH_2, 2H, s), 7.3 (Ph, 5H, m), 10.6 (OH, 1H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −82.2 (CF_3, s). MS, *m/e* (%): 341 (M^+, 10), 326 ($M^+ - CH_3$, 54), 286 (M^+ − t-Bu, 20), 272 ($M^+ - CF_3$, 7), 216 ($M^+ - CF_3$, –*t*-Bu, 20), 57 ($C_4H_9^+$, 92), 43 ($C_3H_7^+$, 100) and other fragments. Analysis: $C_{15}H_{17}F_6NO$ (MG 341.30), Calcd.: C 52.8, H 5.0, F 33.4; Found: C 53.0, H 5.19, F 33.0.

4.17. 1-Isopropylimino-4,4,4-trifluoro-3-trifluoromethyl-butan-3-ol (**25**)

To 1.70 g (20 mmol) **21** in 20 ml diethyl ether 3.3 g (20 mmol) HFA were added at −196 °C. After warming up the solvent was pumped off yielding a white solid; mp 64 °C, yield 4.9 g (98%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (CH_3 *i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 2.7 (CH_2, 2H, d, $^3J_{HH} = 4.7$ Hz), 3.3 (CH *i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 7.1 (OH, 1H, s), 7.8 (=CH, 1H, t, $^3J_{HH} = 4.7$ Hz). ^{19}F NMR ($CDCl_3$), δ (ppm): −82.2 (CF_3, s). MS, *m/e* (%): 252 ($M^+ + H$, 7), 236 ($M^+ - CH_3$, 100), 210 ($M^+ - i$-Pr, 5), 182 ($M^+ - CF_3$–H, 18), 70 (CF_3H^+, 54) and other fragments. Analysis: $C_8H_{11}F_6NO$ (MG 251.17), Calcd.: C 38.25, H 4.4, F 45.4; Found: C 37.6, H 4.1, F 45.6.

4.18. 4-Isopropylamino-1,1,1-trifluoro-2-trifluoromethyl-butan-2-ol (**26**)

To 1.9 g (7.5 mmol) **25** in 20 ml diethyl ether 0.3 g (8 mmol) $LiAlH_4$ in 30 ml diethyl ether were added. The reaction mixture was hydrolyzed with water, the solid residue filtered off and washed with diethyl ether. The organic phase was dried over $MgSO_4$, the solvent pumped off in vacuo yielding an analytical pure liquid; yield 0.4 g (21%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (CH_3 *i*-Pr, 6H, d, $^3J_{HH} = 6.2$ Hz), 1.9 (NCH_2, 2H, t, $^3J_{HH} = 5.7$ Hz), 2.8 (CH *i*-Pr, 1H, sep, $^3J_{HH} = 6.2$ Hz), 3.1 ($CH_2C(CF_3)_2$, 2H, t, $^3J_{HH} = 5.7$ Hz), 5.6 (OH, NH, 2H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −82.3 (CF_3, s). MS, *m/e* (%): 253 (M^+, 6), 238 ($M^+ - CH_3$, 100), 184 ($M^+ - CF_3$, 11) and other fragments. Analysis: $C_8H_{13}F_6NO$ (MG 253.19), Calcd.: C 37.95, H 5.2, F 45.0; Found: C 38.6, H 4.85, F 44.7.

4.19. 4-Isopropylimino-3,3,5-trimethyl-1,1,1-trifluoro-2-trifluoromethylhexan-2-ol (**28**)

To 1.6 g (10 mmol) **27** in 10 ml diethyl ether 1.7 g (10 mmol) HFA was added at −196 °C. All volatiles were pumped off after warming up to ambient temperature to give an analytically pure white solid; mp 59 °C, yield 3.3 g (100%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (CH_3 *i*-Pr, 6H, d, $^3J_{HH} = 6.8$ Hz), 1.2 (CH_3 *i*-PrN, 6H, d, $^3J_{HH} = 6.2$ Hz), 1.3 (CH_3, 6H, s), 2.9 (CH, 2H, m). ^{19}F NMR ($CDCl_3$), δ (ppm): −73.2 (CF_3, s). MS, *m/e* (%): 236 ($M^+ - CH_3$, –CF_3, 16), 112 (M^+–*i*-Pr, –$(CF_3)_2CO$, 28), 70 (CF_3H, 100) and other fragments. Analysis: $C_{13}H_{21}F_6NO$ (MG 321.31), Calcd.: C 48.6, H 6.6, F 35.5; Found: C 48.4, H 6.6, F 35.45.

4.20. 1-Isopropylimino-2,6-dimethyl-2(1′,1′,1′,3′,3′,3′-hexafluoropropan-2′-ol)-cyclohexane (**30a** and **b**)

To 3.3 g (20 mmol) **29** in 15 ml diethyl ether 3.3 g (20 mmol) HFA were added. After pumping off all volatiles an analytically pure yellow oil remains; yield 6.3 g (95%). ^{1}H NMR ($CDCl_3$), δ (ppm): 0.96 (*i*-Pr, 6H, d,

$^3J_{HH}$ = 6.2 Hz), 1.12 (CH_3, 6H, m), 2.89 (CH, 1H, m), 3.76 (*i*-Pr, 1H, sep, $^3J_{HH}$ = 6.2 Hz), 12.21 (OH, 1H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −69.4 (CF_3, 3F, q, $^4J_{FF}$ = 10.1 Hz), −73.6 (CF_3, 3F, q, $^4J_{FF}$ = 10.1 Hz). MS, *m/e* (%): 333 (M^+, 94), 264 ($M^+ - CF_3$, 17), 253 ($M^+ - F$, –*i*-Pr, – H_2O, 100), 167 ($M^+ - (CF_3)_2CO$, 54), 152 ($M^+ - (CF_3)_2CO$, –CH_3, 58) and other fragments. Analysis: $C_{14}H_{21}F_6NO$ (MG 333.32), Calcd.: C 50.45, H 6.35, F 34.2; Found: C 50.7, H 6.5, F 34.3.

4.21. 2-Isopropylamino-4-isopropyliminopent-2-ene (*31*)

To a solution of 20.0 g (200 mmol) acetylacetone and 71.0 g (1200 mmol) isopropylamine in 200 ml diethyl ether 38.0 g (200 mmol) titanium tetrachloride in 20 ml *n*-pentane was added at 0 °C. After warming up to ambient temperature the mixture was refluxed for 1 h, filtered off from the precipitate and washed with diethyl ether. All volatiles were pumped off and the remaining liquid distilled; bp 65 °C (10^{-2} hPa), yield 28 g (77%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.0 (*i*-Pr, 6H, d, $^3J_{HH}$ = 6.2 Hz), 1.1 (*i*-Pr, 6H, d, $^3J_{HH}$ = 6.2 Hz), 1.6 (CH_3, 3H, s), 1.7 (CH_3, 3H, s), 3.5 (CH *i*-Pr, 2H, m), 4.2 (CH, 1H, s). MS, *m/e* (%): 182 (M^+, 82), 167 ($M^+ - CH_3$, 61), 139 ($M^+ -$ *i*-Pr, 100), 125 ($M^+ - CH_3$, –*i*-Pr, 43), 43 ($C_3H_7^+$, 98) and other fragments. Analysis: $C_{11}H_{22}N_2$ (MG 182.31), Calcd.: C 72.5, H 12.2; Found: C 72.5, H 11.9.

4.22. 2-Hydroxy-3-isopropylamino-1,1,1-trifluoro-2-trifluoromethyl-hex-3-en-5-one (*32*)

To 1.4 g (10 mmol) **31** in 10 ml diethyl ether 5.8 g (35 mmol) HFA were added. All volatiles are pumped off in vacuo to yield a red solid; mp 75 °C, yield 2.9 g (94%). ^{1}H NMR ($CDCl_3$), δ (ppm): 1.1 (*i*-Pr, 6H, d, $^3J_{HH}$ = 6.2 Hz), 2.1 (CH_3, 3H, s), 3.1 (CH_2, 2H, s), 3.5 (*i*-Pr, 1H, sep, $^3J_{HH}$ = 6.2 Hz), 5.3 (=CH, 1H, s), 9.5 (NH, 1H, s). ^{19}F NMR ($CDCl_3$), δ (ppm): −80.7 (CF_3, s). MS, *m/e* (%): 307 (M^+, 85), 292 ($M^+ - CH_3$, 48), 264 ($M^+ -$ *i*-Pr, 31), 250 ($M^+ - CH_3$, –*i*-Pr, 44), 196 ($M^+ - CF_3$, –*i*-Pr, 13), 140 ($M^+ - (CF_3)_2COH$, 100) and other fragments. HRMS: for $C_{11}H_{15}F_6NO_2$, Calcd.: 307.10071; Found: 307.10056.

The X-ray structural study was carried out on a Siemens P4 diffractometer using graphite monochromated Mo Kα radiation (λ = 71.073 pm). The structures were solved by *direct methods* and anisotropically refined based on F^2 using the SHELX-97 program package. [17] The C–H hydrogen atoms were placed in calculated positions, assigned common isotropic thermal parameters and allowed to ride on their parent atoms. Crystal data for **2**, colorless crystals, $C_{12}H_{13}F_{12}NO_2$, M = 431.23, orthorhombic, $Pna2_1$, a = 1247.4(2) pm, b = 918.3(2) pm, c = 1390.5(3) pm, $\alpha = \beta = \gamma = 90°$, V = 1.5928(6) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0323, wR_2 = 0.0511, R values (all reflections), R_1 = 0.0393, wR_2 = 0.0528; crystal size 0.5 mm × 0.4 mm × 0.4 mm with Z = 4, reflections measured 4385, unique reflections 2046 (R_{int} = 0.1653). CCDC deposit number 235877 (see http://www.rsc.org/suppdata/). Crystal data for **3**, colorless crystals, $C_{19}H_{34}F_{12}N_2O_2$, M = 490.33, monoclinic, $P2_1/n$, a = 1076.8(1) pm, b = 1863.7(4) pm, c = 1392.8(2) pm, $\alpha = \gamma = 90°$, β = 96.75(1)°, V = 2.7757(8) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0429, wR_2 = 0.0905, R values (all reflections), R_1 = 0.0769, wR_2 = 0.0996; crystal size 0.6 mm × 0.4 mm × 0.3 mm with Z = 4, reflections measured 8537, unique reflections 3610 (R_{int} = 0.0757). CCDC deposit number 235878 (see http://www.rsc.org/suppdata/). Crystal data for **6**, colorless crystals, $C_9H_9F_{12}NO_3$, M = 407.17, orthorhombic, Pbca, a = 1232.5(1) pm, b = 1529.6(1) pm, c = 1586.6(2) pm, $\alpha = \beta = \gamma = 90°$, V = 2.9911(5) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0446, wR_2 = 0.0995, R values (all reflections), R_1 = 0.0750, wR_2 = 0.1135; crystal size 0.5 mm × 0.5 mm × 0.4 mm with Z = 8, reflections measured 5677, unique reflections 2627 (R_{int} = 0.0327). CCDC deposit number 235876 (see http://www.rsc.org/suppdata/). Crystal data for **7**, colorless crystals, $C_{13}H_{15}F_{12}NO_2$, M = 445.26, triclinic, P-1, a = 900.3(2) pm, b = 975.7(3) pm, c = 1091.6(3) pm, α = 93.97(2)°, β = 104.12(2)°, γ = 110.08(1)°, V = 0.8605(4) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0408, wR_2 = 0.1081, R values (all reflections), R_1 = 0.0555, wR_2 = 0.1149; crystal size 2.0 mm × 3.0 mm × 4.0 mm with Z = 2, reflections measured 7927, unique reflections 3935 (R_{int} = 0.0447). CCDC deposit number 235870 (see http://www.rsc.org/suppdata/). Crystal data for **10**, colorless crystals, $C_{12}H_{14}F_{12}N_2O$, M = 430.25, monoclinic, P2(1)/a, a = 1097.4(3) pm, b = 1528.4(3) pm, c = 1117.5(2) pm, $\alpha = \gamma = 90°$, β = 114.58(1)°, V = 1.7045(6) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0496, wR_2 = 0.1117, R values (all reflections), R_1 = 0.0898, wR_2 = 0.1251; crystal size 0.7 mm × 0.6 mm × 0.5 mm with Z = 4, reflections measured 8334, unique reflections 3918 (R_{int} = 0.0841). CCDC deposit number 235871 (see http://www.rsc.org/suppdata/). Crystal data for **13**, colorless crystals, $C_{14}H_{17}F_{12}NO_2$, M = 459.29, monoclinic, P2(1)/c, a = 1561.5(1) pm, b = 1474.8(2) pm, c = 1805.9(2) pm, $\alpha = \gamma = 90°$, β = 114.05(1)°, V = 3.7978(7) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0375, wR_2 = 0.0819, R values (all reflections), R_1 = 0.0575, wR_2 = 0.0905; crystal size 0.6 mm × 0.4 mm × 0.3 mm with Z = 8, reflections measured 10281, unique reflections 4817 (R_{int} = 0.0398). CCDC deposit number 235873 (see http://www.rsc.org/suppdata/). Crystal data for **14**, colorless crystals, $C_{15}H_{17}F_{12}NO_2$, M = 447.30, monoclinic, P2(1)/c, a = 1473.5(3) pm, b = 977.3(2) pm, c = 1358.7(6) pm, $\alpha = \gamma = 90°$, β = 104.33(1)°, V = 1.8957(10) nm^3, final R values $[I > 2\sigma(I)]$, R_1 = 0.0607, wR_2 = 0.1597, R values (all reflections), R_1 = 0.0887, wR_2 = 0.1742; crystal size 0.8 mm × 0.3 mm × 0.3 mm with Z = 4, reflections measured 3160, unique reflections 2347 (R_{int} = 0.0669). CCDC deposit number 235872 (see http://www.rsc.org/suppdata/). Crystal data for **26**, colorless crystals, $C_8H_{11}F_6N_2O$, M = 251.18, monoclinic, P2(1)/c, a = 1023.8(1) pm,

$b = 941.9(1)$ pm, $c = 1165.7(1)$ pm, $\alpha = \gamma = 90°$, $\beta = 114.58(1)°$, $V = 1.7045(6)$ nm^3, final R values $[I > 2\sigma(I)]$, $R_1 = 0.0496$, $wR_2 = 0.1117$, R values (all reflections), $R_1 = 0.0898$, $wR_2 = 0.1251$; crystal size $0.7\,\text{mm} \times 0.6\,\text{mm} \times 0.5\,\text{mm}$ with $Z = 4$, reflections measured 8334, unique reflections 3918 ($R_{\text{int}} = 0.0841$). CCDC deposit number 235875 (see http://www.rsc.org/suppdata/). Crystal data for **28**, colorless crystals, $C_{13}H_{21}F_6NO$, $M = 321.31$, monoclinic, P2(1)/n, $a = 707.8(1)$ pm, $b = 1846.8(2)$ pm, $c = 1194.1(2)$ pm, $\alpha = \gamma = 90°$, $\beta = 94.54(1)°$, $V = 1.5560(4)$ nm^3, final R values $[I > 2\sigma(I)]$, $R_1 = 0.0547$, $wR_2 = 0.1378$, R values (all reflections), $R_1 = 0.0744$, $wR_2 = 0.1511$; crystal size $0.6\,\text{mm} \times 0.5\,\text{mm} \times 0.5\,\text{mm}$ with $Z = 4$, reflections measured 7863, unique reflections 2040 ($R_{\text{int}} = 0.0474$). CCDC deposit number 235874 (see http://www.rsc.org/suppdata/).

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