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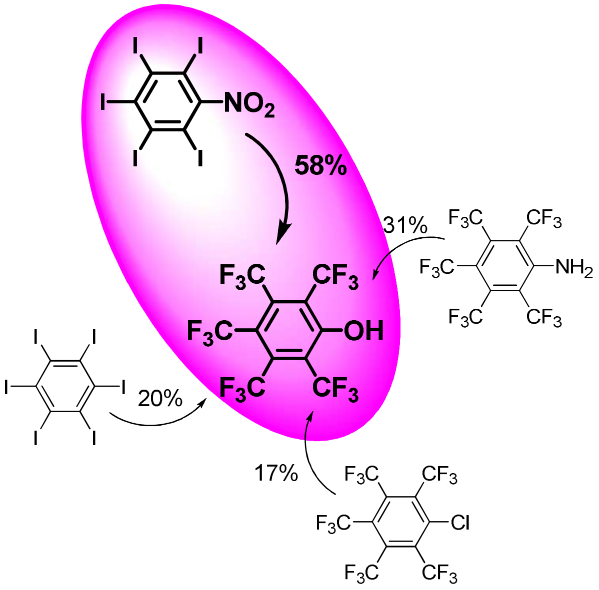

Pentakis(trifluoromethyl)phenol, a long requested compound, is now available within two-step foolproof method from commercially available starting materials with a reasonable high yield (58%).

Pentakis(trifluoromethyl)phenol from Nitrobenzene

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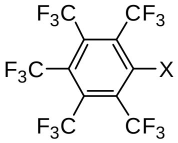
In memory of Alexander A. Kolomeitsev.

Electronic supplementary information (ESI) available: Computational coordinates and structures of compounds **2**, **3**, and nitrobenzene; UV-vis spectra of **1** and **1a**, ^{19}F NMR spectra of the reactions and products; IR-ATR, GC-MS, ESI-HRMS, and HPLC-ESI-MS spectra of products; photograph of blue N_2O_3 in liquid nitrogen trap.

In the present work, two step method from commercially available starting materials obtaining pentakis(trifluoromethyl)phenol is presented. Named phenol has been prepared previously using different methods but all these methods suffer from rather low yield and/or time-consuming purification processes. Until now, larger amount of pure pentakis(trifluoromethyl)phenol has been difficult to prepare. Sufficiently pure pentakis(trifluoromethyl)phenol is now obtained from pentaiodonitrobenzene with 58% yield and after only one time-consuming sublimation process. The phenol forms during trifluoromethylation reaction from pentaiodonitrobenzene; iodides are substituted by trifluoromethyl groups and the nitro group is substituted by an oxygen atom in the oxygen-nucleophilic environment. Small amount of pentakis(trifluoromethyl)phenol is available from the authors on request.

Phenols are very common reagents in chemistry. Trifluoromethylated and polyfluorinated phenols are starting materials for ethers,[1] esters,[2] substituted olefins,[3] sulfonates,[4,5,6] sulfamates,[4] etc. Alkoxy aluminates,[7,8] a class of weakly coordinating anions,[9] are specifically prepared from phenols. The more acidic the phenol, the weaker the anions' coordinating ability. Other types of coordination compounds,[10] catalysts,[11,12] etc. for which phenols are important reagents, are published as well.



X = OH	**1**
O^-	**1a**
NO_2	**2**
NO	**3**
NH_2	**4**
Cl	**5**
H	**6**

Scheme 1. Numeration of compounds.

Pentakis(trifluoromethyl)phenol **1** (Scheme 1) is quite strong acid. Its acid strength (pK_a(MeCN)=10.46)[13] is similar to the acidity of picric acid (pK_a(MeCN)=11.00).[14,15] Pentakis(trifluoromethyl)phenolate **1a** has well delocalized negative charge and the most nucleophilic site of the anion is hidden between two protective *ortho*-CF_3 groups reducing its nucleophilicity. Phenol **1** is a solid (m.p. 88–90 °C) yet volatile substance with a recognizable smell of vanillin that makes the initial detection simple. In case of increased availability of phenol **1**, this compound is envisaged to find several useful applications.

Until now, three different methods have been published obtaining phenol **1**. None of these methods have very high yields and some of the methods include rather inconvenient and time-consuming purification procedures. These methods are: [13, 16]

1) **Trifluoromethylation of hexaiodobenzene with pregenerated $CuCF_3$**. Phenol **1** is obtained as a by-product with the approximate yield of 20%. However, using N-methyl-2-pyrrolidone (NMP) instead of 1,3-dimethyl-2-imidazolidinone (DMI), only traces of **1** were obtained. An increase in formation of **1** in DMI is related to the enhanced oxygen-nucleophilicity of DMI compared to NMP. DMI has approximately 10 times higher price than NMP which makes it almost impossible to use it in large scale trifluoromethylation reactions where it is difficult to recover the used solvents.

2) **Hydrolysis of pentakis(trifluoromethyl)chlorobenzene 5**, yield 38%. Experiments carried out by another operator, only 17% of the yield was obtained after difficult purification process that contained

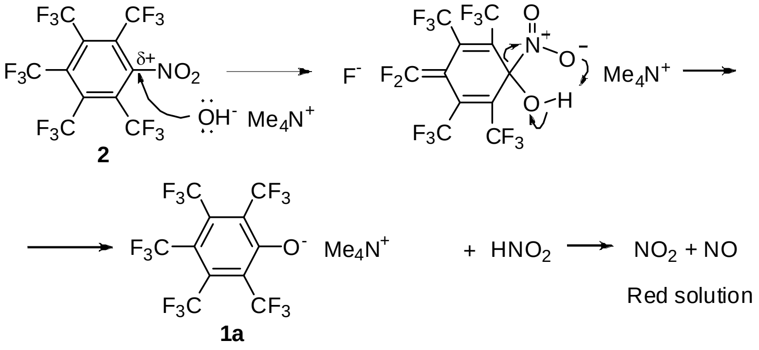
several sublimation procedures, which are very time-consuming. The yield probably depends on the scale of the reaction; it is faster and simpler to sublime smaller amount of the product.

3) **Reaction of pentakis(trifluoromethyl)benzenediazonium cation $C_6(CF_3)_5N_2^+$ with water**. The yield of pure **1** from pentakis(trifluoromethyl)aniline **4** is 39%, similarly with previous method, after several sublimation procedures. Preparation of aniline **4** from chlorobenzene **5** has maximum yield 79%. Therefore, the yield of **1** from pentakis(trifluoromethyl)chlorobenzene **5** is approximately 31% through two steps. Chlorobenzene **5** is prepared from pentaiodochlorobenzene. The whole process takes 4 steps from commercially available compounds.

In addition, phenol **1** was also tried to prepare from pentachlorophenol and pentabromophenol, substituting chlorine or bromine atoms, respectively, by CF_3 groups *via* trifluoromethylation method used also in the present work.[13] $CuCF_3$ did not react with these substances and it was not possible to obtain phenol **1** using these starting materials. It has been reported that bromo-[18,19] or even chloro-substituted[20,21] aromatics can be trifluoromethylated using CF_3^- source and different catalytically active metals but these methods are known to be not too suitable substituting halides in electron-rich arenes.[19,21]

From the reaction of pentakis(trifluoromethyl)benzenediazonium salt with dry $NaNO_2$[16] the mixture of pentakis(trifluoromethyl)nitrobenzene **2** and -nitrosobenzene **3** was obtained. It was very complicated to separate these two compounds because of their very similar volatility and solubility. When Me_4NOH (20% in MeOH) was added into the NMR tube to the mixture of compounds **2** and **3** dissolved in $CDCl_3$, the solution colored red and the product according to ^{19}F NMR spectrum was a single almost pure pentakis(trifluoromethyl)phenyl derivative (See Figure 1 and Spectrum S15 in ESI). Mass-spectrometric analysis of the product that crystallized out from $CDCl_3$ revealed that the compound obtained was pure phenolate **1a** (Spectrum S19).

Formation of pentakis(trifluoromethyl)phenolate **1a** from pentakis(trifluoromethyl)nitrobenzene **2** seems to be a nucleophilic substitution (Scheme 2). Nitrobenzene **2** is an aromatic compound that is fully substituted by highly electronegative groups–five CF_3 groups and one NO_2 group that make the benzene ring extremely electron deficient; partial positive charge on the aromatic carbon atoms is high. *Ipso*-carbon of **2** has especially positive partial charge and eager to bind nucleophiles. When there are OH^- species, strong nucleophiles, in the solution then these attack the *ipso*-carbon, i.e. carbon with the best leaving group on the molecule. Formed intermediate is additionally stabilized by the hyperconjugation of CF_3 groups. Further formation includes a separation of nitrous acid HNO_2 (or HNO in case of nitrosobenzene **3**) and phenolate **1a**. HNO_2 decomposes giving NO_2 and NO into the solution, which makes the solution dark red. The fact that only one equivalent of Me_4NOH is consumed to convert all the nitrobenzene **2** into phenolate **1a** supports also the proposed mechanism on Scheme 2.



Scheme 2. Suggested reaction pathway from nitrobenzene 2 to phenolate 1a by a nucleophile OH^-.

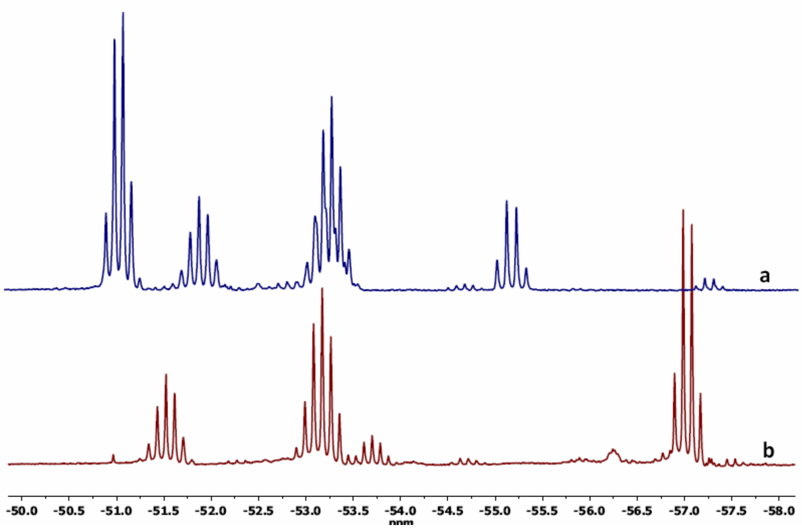
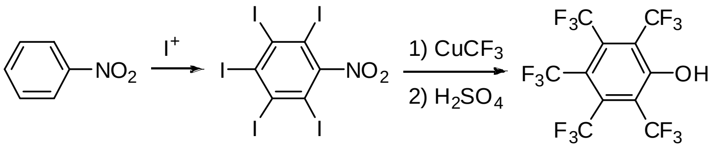


Figure 1. ^{19}**F NMR spectra that shows how the mixture of pentakis(trifluoromethyl)nitrobenzene 2 and -nitrosobenzene 3**^{16} **dissolved in** $CDCl_3$ **(blue spectrum, a) are converted mainly into a single pentakis-(trifluoromethyl)phenyl derivative (red spectrum, b) after treatment with** Me_4NOH **(25% in MeOH). ESI-HRMS measurements revealed that the compound formed is pentakis(trifluoromethyl)phenolate 1a.**

Our initial goal was to obtain pentakis(trifluoromethyl)nitrobenzene **2** from pentaiodonitrobenzene,[22] a known compound, using trifluoromethylation method with pregenerated $CuCF_3$.[13] Obtained nitrobenzene **2** would have been a useful starting material for phenol **1**, aniline **4** and maybe for some other polyfluorinated substances. Instead, surprisingly, it was not possible to obtain nitrobenzene **2** as the product of trifluoromethylation reaction but only phenolate **1a**. No additional steps are now necessary to prepare phenol, but unfortunately, the possibility to obtain nitrobenzene **2** in a large scale is now also vanished. However, aniline **4** can be obtained easily from chlorobenzene **5** with the yield 79%. Nitrobenzene **2** can be obtained from pentakis(trifluoromethyl)benzenediazonium salt reacting it with $NaNO_2$, although only with very low yield (13%).[16] Several nitration methods (nitric acid in the presence of other acids; $AgNO_2/BF_3$ system[23]) of pentakis(trifluoromethyl)benzene **6** were also carried out to get respective nitrobenzene **2** but the efforts were not successful most probably because of too high positive charge on the *ipso*-carbon of the compound **6** and perhaps also due to the steric hindrance by CF_3 groups. It might be possible to obtain nitrobenzene **2** from pentakis(trifluoromethyl)benzene anion but its deprotonation requires rather strong base[13] and anhydrous oxygen free reaction environment into where it might be challenging to include NO_2^+ cation.

Phenol **1** has been an often requested compound from other research groups. The method presented in here obtaining phenol **1** with yield 58% (taking into consideration the purity of pentaiodonitrobenzene–57%, *vide infra*) proceeds *via* two steps starting from commercially available substances, such as nitrobenzene, iodine, periodic acid, conc. H_2SO_4, CuBr, KF, and Ruppert-Prakash reagent. The yield is still not very good but the process itself is well repeatable, sufficiently pure phenol **1** is obtained (Spectra S8 and S22), and the yield is the largest than any yield published so far. Whenever phenol **1** is needed, this method published here would be the method of choice.



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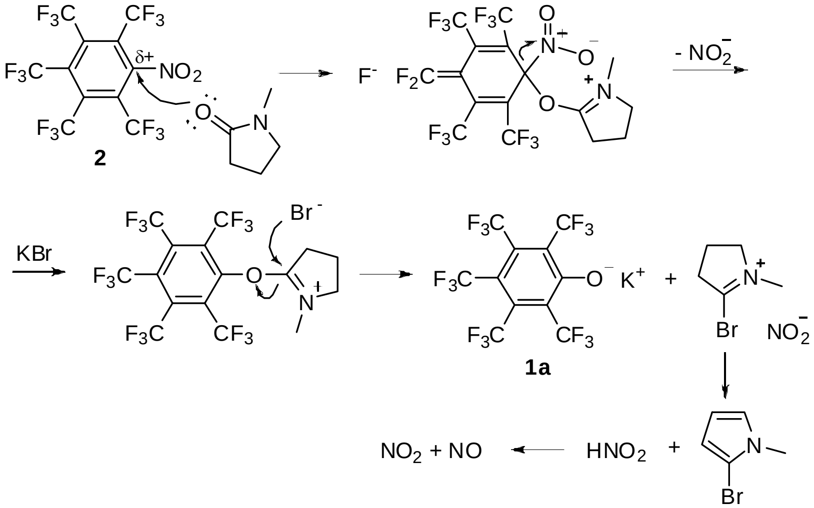
Scheme 3. General route from nitrobenzene to phenol 1.

The first step–periodination–is carried out in conc. H_2SO_4 in the presence of iodine and periodic acid as described in the ref 22. Iodination is not complete and the iodinated product contains pentaiodo and tetraiodo (two isomers) derivatives. When careful recrystallization was performed (two times from the mixture of benzene and ethanol),[24] then pure pentaiodonitrobenzene with the yield 22% was obtained. Chromatographic separation of polyiodinated arenes is not trivial due to the scarce solubility and not sufficient difference in polarity to gain separation. HPLC-ESI-MS-UV-vis analysis showed that crude periodinated product we prepared contained 31% and 12% tetraiodo derivatives and 57% pentaiodo derivative (Spectrum S24, UV-vis measurements at 252-256 nm). After recrystallization, the product contained according to ^{1}H NMR and HPLC-ESI-MS-UV-vis measurements mainly pentaiodonitrobenzene (Spectrum S25). UV-vis peaks were identified according to the signal in ESI negative mode of an adduct of chlorine anion and periodinated nitrobenzene.

The second step–trifluoromethylation–is carried out in the mixture of NMP and DMF into where $CuCF_3$ is pregenerated using CuBr, Ruppert-Prakash reagent and KF. The reaction mixture is stirred overnight; during this time the mixture turns dark brown, most probably from NO_2. Usually it stays lighter brown or even greenish. When the reaction is finished then the solvents and other volatile materials ($FSiMe_3$, less than five CF_3-substituted nitrobenzenes, and decomposition products) are removed by vacuum distillation. Phenolate **1a** is not volatile and remains to the residue; it is extracted from the residue with diethyl ether. Ether is removed by rotary evaporation and crude phenolate **1a** (Spectrum S7) is sublimed from the concentrated sulfuric acid. Sufficiently pure neutral phenol **1** (Spectrum S8) is obtained; no further purification is needed.

On the Scheme 4, the hypothetical reaction pathway from nitrobenzene **2** to phenolate **1a** during trifluoromethylation reaction in DMF and NMP is brought. Instead of nucleophilic OH^- species (Scheme 2), basic oxygen from the solvent NMP attacks the most electrophilic site of the product.



Scheme 4. Possible reaction pathway from nitrobenzene 2 to phenolate 1a by oxygen-nucleophilic solvent NMP during the trifluoromethylation reaction.

A blue compound is trapped into the liquid nitrogen trap (Figure S26) when distilling off the solvents from the reaction mixture. This blue substance turns gaseous when the trap is warming up indicating that N_2O_3

(from NO_2 and NO) forms in the reaction. It is an additional proof to the proposed reaction mechanism on the Scheme 4. Other by-products (for example 2-bromo-1-methylpyrrole) were not identified.

Reaction between pentaiodochlorobenzene and pregenerated $CuCF_3$ proceeds in more predicted way; pentakis(trifluoromethyl)chlorobenzene **5** is obtained besides traces of phenolate **1a** and benzene **6**. If we would have simple nucleophilic substitution process then chlorine atom as the better leaving group than nitro group would be the same way substituted by oxygen atom. Chlorobenzene **5** is not a very good subject to hydrolysis. It seems that besides electronic effects there are strong conformational effects that forces nitrobenzene **2** into phenolate **1a**.

It is known[13] that pentakis(trifluoromethyl)phenyl derivatives are quite crowded substances. The most extreme example so far is the anion of pentakis(trifluoromethyl)phenyl malononitrile $C_6(CF_3)_5C(CN)_2^-$ where the -$C(CN)_2^-$ group needs to be planar with the benzene ring to exhibit the best resonance properties. Since the -$C(CN)_2^-$ group is quite large then the benzene ring takes obvious bath conformation where the angle between two planes (one plane: *ipso* and *ortho* carbon atoms; second plane: *ortho* and *meta* carbon atoms on the benzene ring) is 35° (!) (Table S20 and Figure S3 in SI of ref 13).

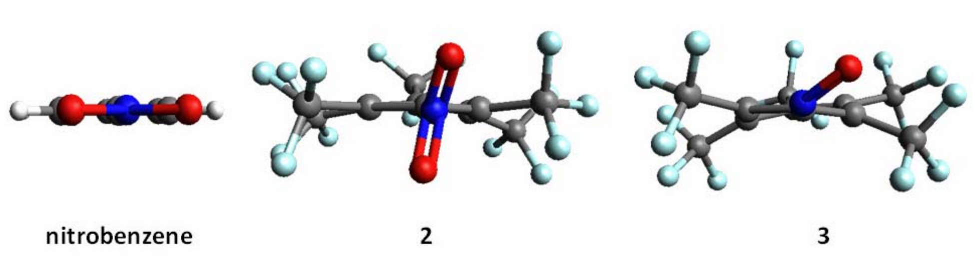


Figure 2. Computational geometries of unsubstituted nitrobenzene, pentakis(trifluoromethyl)nitrobenzene 2 and pentakis(trifluoromethyl)nitrosobenzene 3. The compounds are placed the way the benzene ring is horizontal and the position and angle of nitro or nitroso groups are visible.

Nitro group is not as large as malononitrile but it is larger than halides. It was not possible to get the crystal structure of **2** or **3** because of the extreme volatility and instability of the crystals, even at low temperatures. Often, computational structure does not differ considerably from the experimental crystal structure (Table

S20 of ref 13), therefore in here we examine only the computational structure of compounds **2** and **3** (pages S4-S6 in SI). When anionic malononitrile group forces itself to be planar to the benzene ring, then it is different with nitro- and nitrosobenzene **2** and **3**. The nitro group turns itself out of plane, it is almost transverse to the benzene ring (the angle between the RMS plane of benzene ring and the RMS plane of *ipso*-C and nitro group is 79.1°) and has therefore lowered resonance with aromatic system. Nitroso group turns itself out of plane as well but since it is a little smaller and unsymmetrical, then it is not that transverse to the benzene ring (the angle between the RMS plane of benzene ring and the RMS plane of *ipso*-C, N and O group is 33.6°) and the benzene ring with CF_3 groups has a definite propeller shape (Figure 2 and pages S4-S6 in SI). Since there are no overlapped orbitals that would strengthen the bond between nitro group and benzene ring in this trifluoromethylated system, then the distance between *ipso*-C and nitrogen in case of compounds **2** and **3** are longer than for unsubstituted nitrobenzene. The values are 1.491Å for unsubstitued nitrobenzene, 1.517Å for **2** and 1.535Å for **3**. The electronical and conformational synergy in pentakis(trifluoromethyl)nitrobenzene **2** and -nitrosobenzene **3** make therefore this system sufficiently reactive to bind nucleophiles: nitro and nitroso groups can be detached more simply than for example chlorine atom in oxygen-nucleophilic environment.

In the present work we can distinguish two different trifluoromethylation reactions: one with pentaiodonitrobenzene that contains up to 43% tetraiodonitrobenzenes (hereafter indicated in the text and in ESI as the Reaction I, Spectra S2–S8) and the second one with recrystallized pure pentaiodonitrobenzene (Reaction II, Spectra S9–S14).

Obtaining pure pentaiodonitrobenzene is not trivial, recrystallization is carried out in a rather unpleasant solvents and the recrystallization yield is low. It is encouraged to carry out the trifluoromethylation reaction with the mixture of pentaiodo- and tetraiodonitrobenzenes, as obtained from the periodination reaction, since tetraiodo derivatives do not give phenolates in these conditions and can be removed by vacuum distillation with the solvents.

After trifluoromethylation reaction (Reaction I) the integrals in ^{19}F NMR spectrum show that the crude reaction mixture contains approximately 45% phenolate **1a**, 20% symmetrical nitrobenzene 2,3,5,6-$(CF_3)_4$-C_6HNO_2 and 35% non-symmetrical nitrobenzene 2,3,4,5-$(CF_3)_4$-C_6HNO_2 (Spectrum S2, the position of CF_3 groups in the ring can be obtained from ^{19}F coupling pattern). HPLC-ESI-MS-UV-vis results of periodinated starting materials show the content to be 57, 12, 31%, respectively. It is possible that some of the reactants are reduced during trifluoromethylation reaction giving lower content of phenolate **1a** and higher content of tetrakis(trifluoromethyl)nitrobenzenes. The similar happens when reacting C_6I_6 with $CuCF_3$: one of the product besides phenolate **1a** and $C_6(CF_3)_6$ was $C_6(CF_3)_5H$ **6** (14% yield).[13] The change in percentages in case of this reaction shows that approximately 12% of the pentaiodonitrobenzene is converted into tetrakis(trifluoromethyl)nitrobenzene, mainly to the symmetrical one.

To make sure if tetrakis(trifluoromethyl)nitrobenzene appears during trifluoromethylation process or not, a reaction with pure pentaiodonitrobenzene was carried out (Reaction II). Since there were some problems with the cooling during the operation, then the reaction did not come out too clean. As the result, the main component according to ^{19}F NMR spectrum was still phenolate **1a** but there were approximately 50% of other CF_3 (Spectrum S9, ^{19}F chemical shift range -45–-65 ppm) and C_2F_5 groups (-65–-90 ppm) containing substances, among which both isomers of tetrakis(trifluoromeyhtl)nitrobenzenes with the content up to 30% were present (Spectrum S10). They most probably become from the reduction during trifluoromethylation process. When trifluoromethylation reaction is carried out with pentaiodochlorobenzene, then hydrogen substitutes chlorine atom, not iodine; as a by-product we get benzene **6** not tetrakis(trifluoromethyl)chlorobenzene. The yield of phenol **1** of this specific reaction from pentaiodonitrobenzene is 45%. The purity according to ^{19}F NMR and GC-MS is very high. It means that even when extensive decomposition occurs, it is possible to get pure phenol with reasonable yield and high purity.

It would be interesting to know, if tetrakis(trifluoromethyl)nitrobenzene also gives phenol when reacting it with the Me_4NOH. Adding Me_4NOH (25% in MeOH) to the distillate that contains isomers of tetrakis(trifluoromethyl)nitrobenzenes, a dark red solution forms indicating formation of NO_2 and NO. Later on, the distillate was further worked up and the mixture of tetrakis(trifluoromethyl)nitrobenzenes were separated (see experimental section). We obtained a solid that contained 51% of 2,3,4,5-$(CF_3)_4$-C_6HNO_2 and 49% of 2,3,5,6-$(CF_3)_4$-C_6HNO_2 (according to GC-MS and ^{19}F NMR data, Spectra S6 and S21). Then, the mixture of these two substances was dissolved in MeOH and Me_4NOH (25% in MeOH) was added under stirring as long as the drop of the solution did not colored red. MeOH was removed by rotavapor and the solid obtained was extracted first with pentane and then with chloroform. Pentane extract contains 14% of symmetrical and 86% of non-symmetrical tetrakis(trifluoromethyl)phenyl derivatives, whose chemical shifts now differ from the ppm values of initial compounds. The GC-MS revealed that these compounds are tetrakis(trifluoromethyl)methoxybenzenes (Spectra S16 and S23). Chloroform extract contains according to ^{19}F NMR spectrum a small amount of pentakis(trifluoromethyl)phenolate **1a** with other fluorine containing substances (Spectrum S17). ESI-HRMS shows formation of traces of pentakis- and tetrakis(trifluoromethyl)phenolates (Spectrum S20). The main quantity of the compound was the residue from the extractions that was found out to be tetramethylammonium nitrate (IR-ATR, Spectrum S18).

From this experiment it comes out that nonsymmetrical tetrakis(trifluoromethyl)nitrobenzene is mainly converted into methoxybenzene but symmetrical nitrobenzene seems to decompose more extensively, giving also **1a**. The pathway to 2,3,5,6-$(CF_3)_4$-C_6HOMe goes probably through formed tetramethylammonium methoxide, an extremely strong nucleophile, that reacts with tetrakis(trifluoromethyl)nitrobenzene. The solution turns red or brownish from formed NO_2; tetramethylammonium nitrate forms, when there is a small excess of Me_4NOH, nitrous acid, water or oxygen in the solution.

Conclusion

Pentakis(trifluoromethyl)nitrobenzene **2** and -nitrosobenzene **3** bind in oxygen-nucleophilic environment an oxygen atom and turn into pentakis(trifluoromethyl)phenolate **1a** due to the conformational and electronic properties of the molecules. Phenol **1** forms from pentaiodonitrobenzene during trifluoromethylation reaction with pregenerated $CuCF_3$ in the solvents DMF and NMP. NMP is enough oxygen-nucleophilic that the conversion takes place already during trifluoromethylation reaction. Some of the reactants reduce during trifluoromethylation reaction giving tetrakis(trifluoromethyl)nitrobenzene but not pentakis(trifluoromethyl)benzene as typically obtained in trifluoromethylation reactions with pentaiodochlorobenzene or hexaiodobenzene.

Tetraiodonitrobenzenes are converted into tetrakis(trifluoromethyl)nitrobenzenes during trifluoromethylation reaction. These do not react further with NMP and do not form phenolates and therefore can be easily separated from the formed phenolate **1a**. In the presence of stronger nucleophiles, such as methoxide anion, pentakis(trifluoromethyl)nitrobenzenes also undergo a conversion forming either tetrakis(trifluoromehtl)methoxybenzene or decompose giving traces of phenolate **1a**.

Experimental Section

Used chemicals: Nitrobenzene (pure) was distilled before use; almost white colored (not green as commercial CuBr) CuBr was prepared from $CuSO_4$ (pure), KBr (pure) and Na_2SO_3 (pure) according to reference 25 and dried at 60 °C under vacuum for 6 hours, stored and weighted in glovebox; H_5IO_6 (Sigma-Aldrich, $\geq$ 99.0%), I_2 (99%), conc. H_2SO_4 (95.0-97.0%), NMP (over Molecular Sieve, according to Karl-Fisher titration, water content 8.5 ppm), DMF (over Molecular Sieve, according to Karl-Fisher titration, water content 1.5 ppm), KF (spray-dried, 99%, contains 0.5% SiO_2); CF_3SiMe_3 ($\geq$ 99.0%), Me_4NOH (25% in MeOH) and other common laboratory solvents were used as received.

Methods: NMR spectra were recorded on a 200 MHz spectrometer equipped with 5 mm QNP-z probe for ^{19}F spectra at 188.30 MHz. The chemical shifts are referenced to the internal standard C_6F_6 (-162.59 ppm). All measurements were carried out at 25°C. HRMS-ESI spectra were recorded on a FT-ICR-MS spectrometer. Samples were dissolved in MeCN or in MeOH, no buffer solution was used.

HPLC-ESI-MS-UV-vis measurements were carried out by a device using a polar endcapped C18 analytical column (4.60 mm x 250 mm, 4 mm) with C18 guard cartridge 4.0 mm x 2.0 mm. HPLC conditions were as follows: mobile phase A: buffer solution (pH = 3.2; 1 mM ammonium acetate in 0.1% formic acid); mobile phase B: methanol. The percentage of B was linearly elevated from the initial 40% to 100% in 20 min, followed by 15 min at 100%. The column was maintained at 30 °C and 20 μL of the sample was injected. Samples were dissolved in MeOH. GC-MS spectra were obtained with 70 eV of electron ionization. The GC column was 30 m long and 0.25 mm in diameter capillary column. GC program: 40–150 °C: 5 °C/min; 150–200 °C: 10 °C /min; first 2.8 minutes was not let into mass detector. All samples were dissolved in Et_2O (1–2 % solution) and 1μl was injected. Melting points were determined with capillary melting point apparatus and are uncorrected. To prevent sublimation during the melting procedure the capillaries were sealed before measurements. Computations were carried out by Turbomole 6.5. Geometry optimization was carried out using def-TVZP basis set. Obtained coordinates and values of energy for molecules are brought in SI.

Pentaiodonitrobenzene $C_6I_5NO_2$: The reaction was carried out as published in reference 22. Periodic acid (23.85 g, 0.10 mol) was dissolved in conc. sulfuric acid (375 mL). To the clear solution pounded iodine (78.00 g, 0.30 mol) was added and then stirred using overhead stirrer for half an hour. The reaction mixture was then placed into the ice-bath. Distilled nitrobenzene (7.0 mL, 0.067 mol) was added over 15 minutes. The mixture was then stirred one day on the room temperature and then one day at 95 °C. After heating the reaction mixture to 95 °C for one day, the iodine had been sublimed on the top of the flask. The solution was then carefully poured onto ice trying to avoid iodine to come along. The yellow suspension was then filtered but not washed with ethanol because the product is soluble in this solvent. Pentaiodonitrobenzene on the filter was instead recrystallized using continuous extractor (Soxhlet extractor may be used as well) from AcOEt (400 mL). One batch of the product was filtered. The volume of the AcOEt was then reduced to 200 mL and the solution placed into refrigerator. Yellow precipitate obtained was filtered again, two batches were combined, washed with hexane (200 mL) and dried in the vacuum (10^{-3} Torr) at 50 °C for six hours.

Obtained 36.4 g of the mixture of penta- (57%) and tetraiodonitrobenzenes (43%).

Recrystallization twice from benzene and ethanol[24] gave according to ^{1}H NMR spectrum and HPLC-ESI-MS-UV-vis measurements the substance that has no aromatic hydrogens. Recrystallization yield 22 %.

Pentakis(trifluoromethyl)phenol $C_6(CF_3)_5OH$ **1**: The reaction was carried out as described for C_6I_5Cl in reference 16. Instead of C_6I_5Cl, $C_6I_5NO_2$ (may contain $C_6I_4HNO_2$ derivatives) was used: Dispersion of CuBr (9.71 g, 0.050 mol) and DMF (50 mL) was cooled to 0 °C, trifluoromethyltrimethylsilane (9.50 mL, 0.067 mol) was added. After that, KF (3.86 g, 0.066 mol) was added slowly *via* solid addition funnel. Then, NMP (10 mL) was included and the reaction mixture was stirred on the ice-bath for 1.5–2 hours to form active $CuCF_3$. $C_6I_5NO_2$ (7.70 g, contains 0.006 mol pentaiodonitrobenzene, and 0.005 mol isomers of tetraiodonitrobenzenes) and additional NMP (40 mL) was added. The reaction mixture was stirred overnight and solvents with other volatile substances were distilled off. The residue contains phenolate **1a** which is further worked up. It is important to remove as much as possible the high boiling solvents from the residue to simplify following workup. It helps if the residue is washed also with pentane to remove solvents but not phenolate **1a**. Phenolate **1a** was then extracted into diethyl ether (3 x 70 mL). Ether was evaporated, the solid obtained was transferred into sublimation apparatus, conc. H_2SO_4 (8 mL) was added and phenol **1** sublimed at 60–70 °C at static vacuum (4-5 Torr).

If the residue contains NMP or DMF after distillation, then it is not possible to solidify the product after removal of ether; oily substance is obtained instead, which has to be transferred into sublimation apparatus dissolving it in the small amount of ether. Before addition of conc. H_2SO_4 and sublimation, ether has to be removed carefully to prevent bubbling up the solution.

Phenol **1** obtained after sublimation is slightly hygroscopic, let the sublimation finger to warm up before scraping off the product. Yield from pentaiodonitrobenzene (it has been taken into account the content of tetraiodo nitrobenzenes from HPLC-UV-vis measurements–57%) of phenol **1** is 58% (1.45 g, 0.003 mol).

M.p. 88-90 °C (lit. 88-90 °C)[13,16]

^{19}F NMR spectrum of crude reaction mixture (Reaction I, Spectrum S2) shows that there are 64% 2,3,4,5-$(CF_3)_4$-C_6HNO_2 and 36% 2,3,5,6-$(CF_3)_4$-C_6HNO_2 (percentages are converted to 100% leaving out **1a**). After distillation, according to ^{19}F NMR spectrum, the ratio is changed to 54 and 46%, respectively (Spectrum S3). The content of symmetrical nitrobenzene has risen. There were also no considerable amount of 2,3,4,5-$(CF_3)_4$-C_6HNO_2 in the cold-trap. It may be, that some of the CF_3 substituted nitrobenzene decomposed during the distillation.

The distillate was worked up as follows: water (25 mL) was added to the distillate (100 mL) and extracted with pentane (3x50 mL). Pentane was removed by rotary evaporation the way that the flask is kept cold to prevent sublimation of the compounds. To the oily substance obtained, 2 mL of water was added; crystals formed into this solution. The solution was filtered and solid on the filter recrystallized from the pentane (25 mL). Obtained solid is the mixture of 2,3,4,5-$(CF_3)_4$-C_6HNO_2 (51%) and 2,3,5,6-$(CF_3)_4$-C_6HNO_2 (49%) (Spectra S6 and S21).

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