Naked Fluorides

"Naked" fluorides are fluoride salts with large, mostly organic, cations which are soluble in aprotic solvents. **Tetraalkylammonium fluorides** are most prominent among them. FLUKA offers the tetraalkylammonium fluorides as defined hydrates. The anhydrous salts are not stable. When TBAF.$3H_2O$ is subjected to further drying, it decomposes to tetrabutylammonium hydrogen difluoride and the volatile products tributylamine, 1-butene and water[2]. TEAF.$2H_2O$ behaves similarly[3]. If it is tried to dry solutions of TBAF.$3H_2O$ in various solvents, the solutions decompose under discoloration. The lipophilicity of the tetraalkylammonium fluorides increases from Me_4NF over $BnMe_3NF$ to Bu_4NF and thus their solubility in apolar solvents also increases. Solutions of "naked" fluorides in aprotic solvents contain the fluoride ion unsolvated. This is much more nucleophilic and basic than the fluoride ion of lower alkali metal fluorides (LiF, NaF, KF) in protic solvents.

"Naked" fluorides are very effective bases. They allow many reactions, like alkylation, esterifications, condensation and elimination reactions etc. to be carried out milder and in higher yields than by using other bases[1].

"Naked" fluoride ions are very reactive in desilylation reactions generating "naked" carbanions, enolate ions, alkoxides, etc. useful for many reactions, e.g.

- crossed aldol condensations of silylenol ether with aldehydes[4],
- regioselective monoalkylation of silylenol ethers[5-7]
- generation of intermediate carbanions from C-silicon compounds: reaction with carbonyl compounds[8-14] or elimination reactions[15,16],
- removal of various phosphate and hydroxyl-silyl protecting groups in nucleotides[21-24],
- cleavage of the 2-(trimethylsilyl)ethyl protecting group[25,26],
- mild silylation of ketones to Z-silylenol ethers with ethyl trimethylsilylacetate (FLUKA 92756)[27].

"Naked" fluorides are strong nucleophiles: substitution reaction of other aliphatic halogenides or sulfonates by fluoride[17-20],

Tetrabutylammonium fluoride on Silica gel is non-hygroscopic and easily removed from the reaction mixture by filtration[28,29].

Fluoride polymer supported (Amberlyst A-26 F^--form) is a convenient source of "naked" fluoride[30-34].

Cesium fluoride is the alkali metal fluoride with the largest cation diameter and thus the best solubility in organic solvents. Cesium fluoride was often employed: e.g. generation of carbanions from C-silicon compounds[29,35,36]; in the presence of tetraalkoxysilane as catalyst for Michael additions[37,38] or aldol condensations[39]; together with silanes for the selective reduction of carbonyl compounds[40]; as base[1], for elimination reactions[41].

Potassium fluoride on aluminum oxide is a remarkably efficient base[42-46].

References

1) J.H. Clark, Chem. Rev. *80*, 429 (1980)
2) R.K. Sharma, J.L. Fry, J. Org. Chem. *48*, 2112 (1983)
3) W.T. Miller et al., J. Am. Chem. Soc. *82*, 3091 (1960)
4) E. Nakamura, I. Kuwajima, J. Am. Chem. Soc. *99*, 961 (1977); R. Noyori et al., ibid. *99*, 1265 (1977); E. Nakamura et al., J. Org. Chem. *48*, 932 (1983)
5) I. Kuwajima, E. Nakamura, J. Am. Chem. Soc. *97*, 3257 (1975)
6) M. Samson, M. Vandewalle, Synth. Commun. *8*, 231 (1978)
7) I. Kuwajima et al., J. Am. Chem. Soc. *104*, 1025 (1982)
8) E. Nakamura et al., Tetrahedron Lett. 1699 (1976)
9) E. Nakamura, I. Kuwajima, Angew. Chem. *88*, 539 (1976)
10) A. Hosomi et al., Tetrahedron Lett. 3043 (1978)
11) J. Pornot, ibid *22*, 455 (1981)
12) T. Hirao et al., Bull. Chem. Soc. Jpn. *55*, 1163 (1982)
13) A. Hosomi et al., J. Org. Chem. *48*, 3122 (1983)
14) I. Kuwajima et al., Tetrahedron *39*, 975 (1983); B. Bennetan, J. Dunogues, Tetrahedron Lett. *24*, 4217 (1983)
15) P.J. Kocienski, Tetrahedron Lett. 2649 (1979)
16) Y. Ito et al., J. Org. Chem. *46*, 1043 (1981); R.F. Cunico, Y.-K. Han, J. Organomet. Chem. *105*, C29 (1976); L.A. Paquette et al., J. Org. Chem. *49*, 1317 (1984)
17) C.M. Sharts, W.A. Sheppard, Org. Reactions *21*, 125 (1974)
18) D.P. Lopes, N.F. Taylor, Carbohydr. Res. *73*, 125 (1979)
19) I. Rico et al., Tetrahedron Lett. *22*, 3405 (1981)
20) R. Albert et al., J. Carbohydr. Chem. *1*, 289 (1983)
21) K.K. Ogilvie et al., Can. J. Chem. *56*, 2768 (1978)
22) K.K. Ogilvie, S.L. Beaucage, Nucleic Acids Res. *7*, 805 (1979)
23) J. Imai, P.F. Torrence, J. Org. Chem. *46*, 4015 (1981)
24) E. Ohtsuka et al., Chem. Pharm. Bull. *31*, 1910 (1983)
25) P. Sieber, Helv. Chim. Acta *60*, 2711 (1977)
26) H. Gerlach, ibid. *60*, 3039 (1977)
27) I. Kuwajima et al., Org. Synth. *61*, 122 (1983)
28) J.H. Clark, Chem. Commun. 789 (1978)
29) A. Ricci et al., Tetrahedron Lett. *23*, 577, 5079 (1982)
30) C.L. Borders et al., J. Org. Chem. *37*, 3549 (1972)
31) G. Cainelli et al., Synthesis 472 (1976)
32) Y.M. Miller, K.-H. So, Chem. Commun. 466 (1978)
33) K. Horiki, Synth. Commun. *8*, 515 (1978)
34) S. Colonna et al., J. Chem. Soc. Perkin I, 2248 (1979)
35) M. Obayashi, K. Kondo, Tetrahedron Lett. *23*, 2327 (1982)
36) E. Vedejs, F.G. West, J. Org. Chem. *48*, 4773 (1983); T. Kawashima et al., Tetrahedron Lett. *24*, 739 (1983)
37) C. Chuit et al., Tetrahedron Lett. *23*, 5531 (1982)
38) J. Boyer et al., Tetrahedron *39*, 117 (1983)
39) C. Chuit et al., Synthesis 294 (1983)
40) J. Boyer et al., ibid. 558 (1981); Tetrahedron *37*, 2165 (1981)
41) A. Chollet et al., Helv. Chim. Acta *62*, 511 (1979)
42) J. Yamawaki et al., Chem. Lett. 755 (1979), 533 (1980), 1143 (1981)
43) T. Ando et al., Bull. Chem. Soc. Jpn. *55*, 2504 (1982)
44) J. Yamawaki et al., ibid. *56*, 1885 (1983)
45) J.H. Clark et al., Chem. Lett. 1145 (1983)
46) J.H. Clark, D.G. Cork, J. Chem. Soc. Perkin I, 2253 (1983)

13985	**Benzyltrimethylammonium fluoride Monohydrate pract.** >90%(NT) $C_6H_5CH_2N(F)(CH_3)_3.H_2O$ $C_{10}H_{16}FN.H_2O$ M_r 187.25 [329-97-5]	5 g sFr. 20.–	US$ 15.00
		25 g sFr. 85.–	US$ 63.75
20990	**Cesium fluoride purum** >99%; H_2O <1% CsF M_r 151.90 [13400-13-0]	10 g sFr. 22.–	US$ 16.50
		50 g sFr. 75.–	US$ 56.25
47060	**Fluoride polymer supported** (Amberlyst A-26 F-form) ~3.5-4.0 mmol F^-/g resin Ⓟ-$C_6H_4CH_2N(CH_3)_3F$	10 g sFr. 32.–	US$ 24.00
		50 g sFr. 135.–	US$ 101.25
60242	**Potassium fluoride spray dried purum** >99%(T) KF FK M_r 58.10 [7789-23-3]	250 g sFr. 29.–	US$ 21.75
		1 kg sFr. 95.–	US$ 71.25
60244	**Potassium fluoride on aluminum oxide** contains ~5.5 mmol F^-/g Al_2O_3-KF	25 g sFr. 20.–	US$ 15.00
		100 g sFr. 70.–	US$ 52.50
86872	**Tetrabutylammonium fluoride Trihydrate, TBAF purum** >98%(NT) $(CH_3CH_2CH_2CH_2)_4N(F).3H_2O$ $C_{16}H_{36}FN.3H_2O$ M_r 315.42 [429-41-4]	10 g sFr. 22.–	US$ 16.50
		50 g sFr. 90.–	US$ 67.50
		250 g sFr. 350.–	US$ 262.50
86876	**Tetrabutylammonium fluoride on Silica gel** ("Fluoride" on Silica gel; TBAF on Silica gel) 1.16 mmol F^-/g reagent	25 g sFr. 40.–	US$ 30.00
		100 g sFr. 145.–	US$ 108.75
86615	**Tetraethylammonium fluoride Dihydrate, TEAF purum** >97%(NT) $(C_2H_5)_4N(F).2H_2O$ $C_8H_{20}FN.2H_2O$ M_r 185.28 [665-46-3]	5 g sFr. 10.–	US$ 7.50
		25 g sFr. 33.–	US$ 24.75
		100 g sFr. 120.–	US$ 90.00
87723	**Tetramethylammonium fluoride Tetrahydrate, TMAF purum** >98%(F); M.P. 46-48° $(CH_3)_4N(F).4H_2O$ $C_4H_{12}FN.4H_2O$ M_r 165.21 [373-68-2]	10 g sFr. 18.–	US$ 13.50
		50 g sFr. 75.–	US$ 56.25

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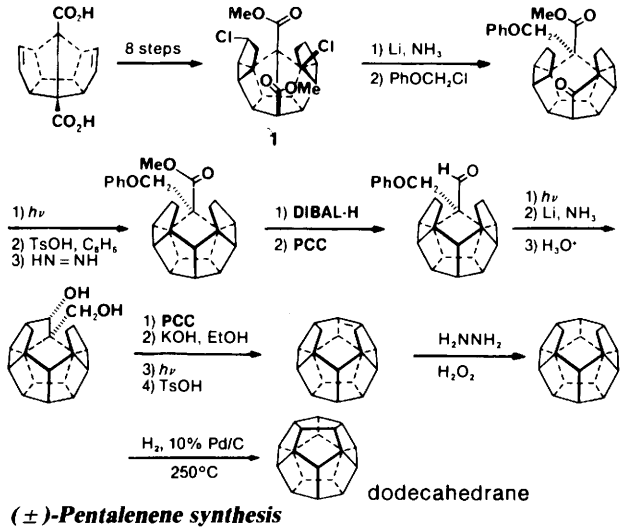
Award-Winning Chemistry

1984 – Professor Leo A. Paquette

Leo A. Paquette, Kimberly Professor of Chemistry at The Ohio State University, is the recipient of the 1984 ACS Award for Creative Work in Synthetic Organic Chemistry, sponsored by Aldrich. Professor Paquette's research interests include the construction of theoretically interesting organic molecules of unusual structure, the synthesis of naturally occurring polycyclopentanoid metabolites, and the formulation of new synthetic methodology based on silicon chemistry. The following highlight some recently reported examples of his synthetic work.

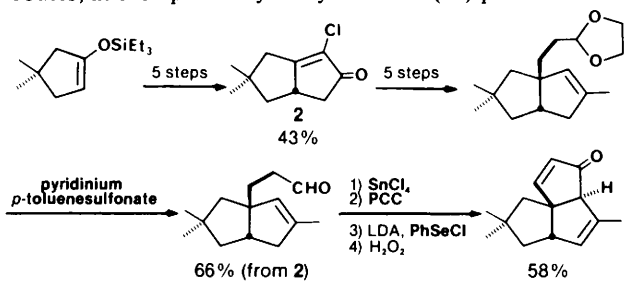
Dodecahedrane synthesis

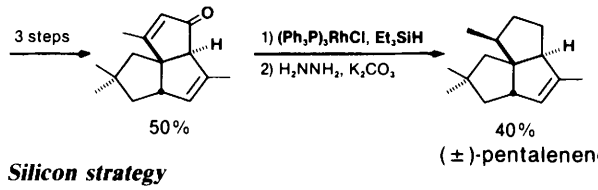
Probably the crowning achievement to over twenty years of Paquette's synthetic work was realized with the total synthesis of dodecahedrane,[1] the organic chemist's transliteration of the most complex of the five regular polyhedra described in Plato's *Timaeus*.[2] Both monomethyl-[3] and 1,16-dimethyldodecahedrane[2] have also been prepared in Professor Paquette's laboratory from intermediate **1**.



(±)-Pentalenene synthesis

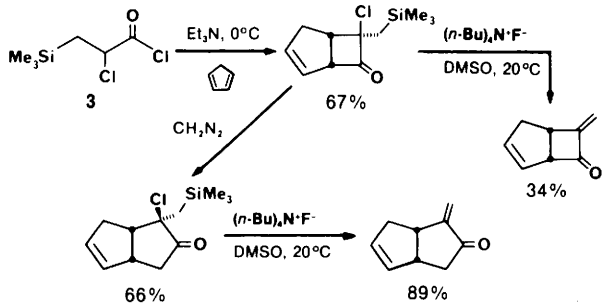
In recent years Professor Paquette has reported the synthesis of several racemic sesquiterpenoid metabolites possessing a tricyclo[6.3.0.0^{1,5}]undecane skeleton (*e.g.*, (±)-isocomene,[4] -silphinene,[5] -retigeranic acid,[6] -pentalenolactone E methyl ester[7]) *via* efficient stereocontrolled routes, as exemplified by his synthesis of (±)-pentalenene.[8]





Silicon strategy

Paquette has recently demonstrated that chloro[(trimethylsilyl)methyl]ketene, readily available from the α-chloro acid chloride **3**, is a viable intermediate for the construction of α-methylenecyclobutanones and -cyclopentanones.[9]



References:

1) Ternansky, R.J.; Balogh, D.W.; Paquette, L.A. *J. Am. Chem. Soc.* **1982**, *104*, 4504.
2) Paquette, L.A.; Balogh, D.W. *ibid.* **1982**, *104*, 774.
3) Paquette, L.A.; Ternansky, R.J.; Balogh, D.W. *ibid.* **1982**, *104*, 4502.
4) Paquette, L.A.; Han, Y.K. *ibid.* **1981**, *103*, 1835.
5) Paquette, L.A.; Leone-Bay, A. *ibid.* **1983**, *105*, 7352.
6) Roberts, R.A.; Schull, V.; Paquette, L.A. *J. Org. Chem.* **1983**, *48*, 2076.
7) Paquette, L.A.; Schostarez, H.; Annis, G.D. *J. Am. Chem. Soc.* **1982**, *104*, 6646.
8) Paquette, L.A.; Annis, G.D. *ibid.* **1983**, *105*, 7358.
9) Paquette, L.A.; Valpey, R.S.; Annis, G.D. *J. Org. Chem.* **1984**, *49*, 1317.