



ChemFiles

Fluorous Synthesis and Separation

Vol. 4 No. 9

Fluorous Protecting Groups

Fluorous Scavengers

Fluorous Ligands and
Organometallic Complexes

Fluorous Reagents

Fluorous Building Blocks
and Precursors

Fluorous Tin Compounds

Fluorous Separation Media

Fluorous RP-Silica Gel
Supports

Fluorous Solvents

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Sigma-Aldrich now offers products from Fluorous Technologies, Inc. to our customers worldwide. Below, please find in detail our broad range of fluorine-rich reagents, catalysts, ligands, protecting groups, scavengers, solvents, and especially separation media for solid-phase extraction of fluorous compounds.

Fluorous techniques are applicable to both green chemical process development and chemical discovery research.

Fluorous chemistry improves productivity through efficient purification. Fluorous systems are nearly as straightforward as resins, offering a general, robust, selective, and orthogonal separation method to isolate products from reaction mixtures. Unlike resins, however, fluorous chemistry also features the kinetic efficiency of solution-phase, the ability to do in-process analytical monitoring, and access to the full lexicon of familiar solution-phase reactions. A wide range of solution-phase organic reactions can be adapted to exploit fluorous advantages without change to the synthetic strategy. As a true homogeneous support, fluorous tags can even be used in transformations that are not accessible when using solid-phase approaches. Fluorous methods are attractive and easy to apply because the experimental techniques (solution-phase reactions, liquid-liquid extractions, solid-phase extractions) are familiar to practicing organic chemists. In addition to being compatible with a wide variety of chemical reactions, fluorous chemistry is also compatible with several new synthesis technologies, including automated synthesis, the use of supercritical CO₂, and microwave synthesis.

Five different types of techniques are described in the literature: fluorous biphasic catalysis, fluorous triphasic

reactions, fluorous reagents and reactants, fluorous substrates, and fluorous mixture synthesis. For an overview, please refer to the review articles listed below. Many of these new techniques are especially suited to the preparation of combinatorial libraries by solution-phase parallel synthesis. The techniques differ in the size and nature of the fluorous tag, in the reaction conditions, and in the separation method.

As a general guideline Rf-tagged products with high fluorine content (heavy fluorous compounds) are appropriate for tagging of diverse organic molecules and recommended for natural products or medicinal chemistry synthesis in combination with liquid-liquid extraction or fluorous solid-phase extraction. Homologous Rf-tagged products with lower fluorine content (light fluorous compounds) are useful in fluorous chromatography or fluorous mixture synthesis. Products with smaller Rf-tags have advantages of lower molecular weight and increased solubility in organic solvents. Thereby, fluorous solvents are not necessary during the reaction, and the fluorous phase (either solid or liquid) is used only in the separation step. Sigma-Aldrich offers products for both heavy and light fluorous chemistry.

General Reviews on Fluorous Techniques:

[1] Gladysz, J. A.; Curran, D. P. *Tetrahedron* **2002**, *58*, 3823–3825; [2] Tzschucke, C.C.; Markert, C.; Bannwarth, W.; Roller, S.; Hebel, A.; Haag, R. *Angew. Chem. Int. Ed. Engl.* **2002**, *41*, 3964–4000; [3] Curran, D. P.; Hadida, S.; Studer, A.; He, M.; Kim, S.-Y.; Luo, Z.; Larhed, M.; Hallberg, A.; Linclau, B. In *Combinatorial Chemistry: A Practical Approach*; H. Fenniri, Ed.; Oxford Univ Press: Oxford, 2000; Vol. 2, pp 327–352; [4] Curran, D. P. In *Stimulating Concepts in Chemistry*, Wiley-VCH, 2000, 25–37; [5] de Wolf, E.; Van Klotten, G.; Deelman, B.-J. *Chem. Soc. Review* **1999**, *28*, 37–41; [6] Betzemeier, B.; Knochel, P. *Top. Curr. Chem.* **1999**, *206*, 61–78; [7] Fish, R. H. *Chem. Eur. J.* **1999**, *5*, 1677–1680; [8] Maul, J. J.; Ostrowski, P. J.; Ublacker, G. A.; Linclau, B.; Curran, D. P. In *Topics in Current Chemistry, Modern Solvents in Organic Synthesis*; P. Knochel, Ed.; Springer-Verlag: Berlin, 1999; Vol. 206, pp 80–104; [9] Curran, D. P. *Angew. Chem. Int. Ed. Engl.* **1998**, *37*, 1175–1196; [10] Horváth, I. T. *Acc. Chem. Res.* **1998**, *31*, 641–650.



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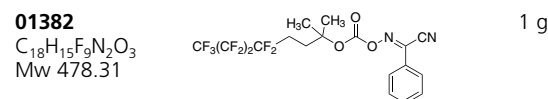
update on the latest Sigma-Aldrich products. When you cannot find a compound or reagent for your Fluorous Synthesis or a fluorinated building block for your research in Drug Discovery, we welcome your input and will use it to broaden our product range even further. Please contact us at hkohlbau@europe.sial.com for new suggestions!

1. Rf-tagged Protecting Groups—Temporary, Cleavable, Fluorous Tags

1.1 F-Boc-ON

F-Boc-ON is the fluorous equivalent of 2-(tert-butoxycarbonyloxyimino)-2-phenylacetoneitrile (Boc-ON) used in protecting amino groups in peptide synthesis or other functionalities in multi-step organic synthesis. Protection of the amino group with F-Boc-ON and deprotection are achieved under traditional reaction conditions, with the advantage

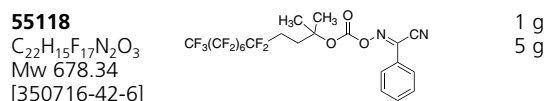
2-[(4,4,5,5,6,6,7,7,7-Nonafluoro-1,1-dimethylheptyloxy) carbonyloxyimino]-2-phenylacetoneitrile,¹ ≥97%



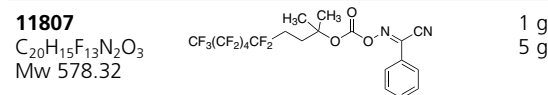
that products containing the F-Boc group can easily be separated from organic reagents, reactants, or products by performing a quick fluorous solid-phase extraction over FluoroFlash® Silica Gel (see sections 8 and 9).^[1,2]

Lit.: [1] Luo, Z. Y.; Williams, J.; Read, R. W.; Curran, D. P. *J. Org. Chem.* **2001**, *66*, 4261; [2] Curran, D. P. *Synlett* **2001**, 1488.

2-[(4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoro-1,1-dimethylundecyloxyimino)-2-phenylacetoneitrile,¹ ≥97%



2-[(4,4,5,5,6,6,7,7,8,8,9,9,9-Tridecafluoro-1,1-dimethylnonyloxy) carbonyloxyimino]-2-phenylacetoneitrile,¹ ≥97%



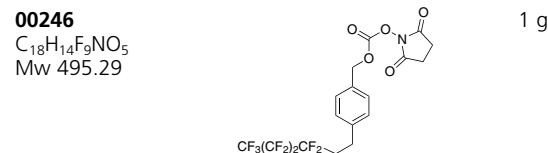
1.2 F-Cbz-OSu

F-Cbz-OSu is the fluorous equivalent of benzyloxycarbonylsuccinimide (Cbz-OSu) used in protecting amino groups in peptide synthesis or multi-step organic synthesis. Protection of the amino group with F-Cbz-OSu and subsequent deprotection are achieved with traditional reaction conditions, with the advantage that products containing the

F-Cbz group can easily be separated from organic reagents, reactants, or products by performing a quick fluorous solid-phase extraction over FluoroFlash® Silica Gel (see sections 8 and 9).^[1,2]

Lit.: [1] Curran, D. P.; Amatore, M.; Guthrie, D.; Campbell, M.; Go, E.; Luo, Z. *J. Org. Chem.* **2003**, *68*, 4643; [2] Curran, D. P. *Synlett* **2001**, 1488.

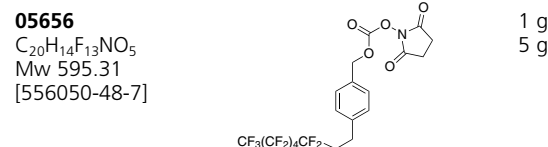
N-[4-(3,3,4,4,5,5,6,6,6-Nonafluorohexyl)benzyloxycarbonyloxy] succinimide,¹ ≥95%



N-[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl)benzyloxycarbonyloxy] succinimide,¹ ≥97%



N-[4-(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl)benzyloxycarbonyloxy] succinimide,¹ ≥97%



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1.3 F-PMB-OH

F-PMB-OH is the fluorinated equivalent of p-methoxybenzyl alcohol (PMB-OH) used in protecting alcohols in multi-step organic synthesis.

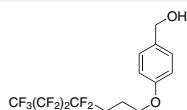
Protection of an alcohol with F-PMB-OH and deprotection are achieved under traditional reaction conditions.^[1,2]

Lit.: [1] Curran, D. P.; Furukawa, T. *Org. Lett.* 2002, 2233; [2] Curran, D. P. *Synlett* 2001, 1488.

4-(4,4,5,5,6,6,7,7,7-Nonafluoroheptyloxy)benzyl alcohol,¹ ≥97%

01452

C₁₄H₁₃F₉O₂
Mw 384.24

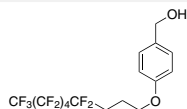


1 g

4-(4,4,5,5,6,6,7,7,8,8,9,9,9-Tridecafluorononyloxy)benzyl alcohol,¹ ≥97%

67772

C₁₆H₁₃F₁₃O₂
Mw 484.25



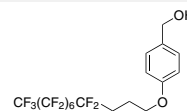
1 g

5 g

4-(4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoro-undecyloxy)benzyl alcohol,¹ ≥97%

97071

C₁₈H₁₃F₁₇O₂
Mw 584.27



1 g

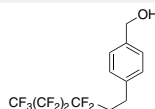
5 g

1.4 F-Benzyl Alcohol

4-(3,3,4,4,5,5,6,6,6-Nonafluorohexyl)benzyl alcohol,¹ ≥95%

08431

C₁₃H₁₁F₉O
Mw 354.21

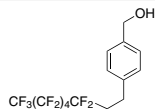


1 g

4-(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl)benzyl alcohol,¹ ≥97%

16638

C₁₅H₁₁F₁₃O
Mw 454.23
[356055-76-0]



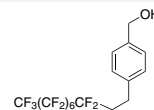
1 g

5 g

4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl)benzyl alcohol,¹ ≥98%

19563

C₁₇H₁₁F₁₇O
Mw 554.24
[356055-77-1]



1 g

5 g

1.5 FluoMar™

FluoMar™ is the fluorinated equivalent of the Marshall resin used frequently as a carbonate and carbamate linker in solid-phase syntheses.^[1,2] This reagent can be used as an alternative to the Marshall resin in solution-phase combinatorial and parallel synthesis. Tagging of substrates is achieved with traditional reaction conditions, with the advantage that

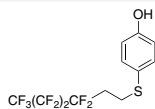
products or intermediates containing the tag (FluoMar™) group can easily be separated from organic reagents, reactants or products by performing a quick solid-phase extraction over FluoroFlash® silica gel.^[3]

Lit.: [1] Chen, C. H.-T.; Zhang, W. *Org. Lett.* 2003, 5, 1015; [2] Marshall, D. L.; Liener, I. E. *J. Org. Chem.* 1970, 35, 867; [3] Curran, D. P. *Synlett* 2001, 1488.

4-(3,3,4,4,5,5,6,6,6-Nonafluorohexylthio)phenol,¹ ≥90%

43849

C₁₂H₉F₉OS
Mw 372.25

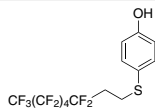


1 g

4-(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctylthio)phenol,¹ ≥97%

43893

C₁₄H₉F₁₃OS
Mw 472.26



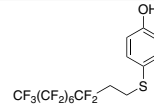
1 g

5 g

4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecylthio)phenol,¹ ≥97%

40829

C₁₆H₉F₁₇OS
Mw 572.28
[142623-70-9]



1 g

5 g

¹ The Rf-tagged protecting groups are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539. FluoMar is a trademark of Fluorous Technologies, Inc.

2. Rf-tagged Solution-Phase Scavengers

Rf-tagged Solution-Phase Scavengers are fluorinated versions of familiar electrophilic and nucleophilic scavengers. Perfluoroalkyl tags are introduced to the scavenging moiety and subsequently facilitate rapid separation of the scavenged species from target products using fluorinated, packed SPE cartridges, chromatography, or liquid extraction. The strategy is the same as for conventional resin or silica-supported scavengers, except that fluorinated-supported scavengers allow to work in homogenous solutions.

Advantages over solid-phase scavengers include:

- Rapid quenching without large excess of scavenging reagent
- Scalability
- Separation by either solid-phase or liquid-liquid extraction
- Chemically inert and thermally stable tags

2.1 Rf-tagged Nucleophilic Scavengers

2.1.1 F-Thiols

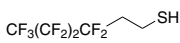
Thiols are good nucleophiles that have been used as covalent scavengers to rid product mixtures of excess halides and other electrophiles. F-Thiol is the solution-phase equivalent of polymer bound thiol scavengers. It has the advantage of reacting faster than its polymer counterpart.^[1] F-Thiol-quenched derivatives can be easily separated from the organic product by performing a quick solid-phase extraction over FluoroFlash[®] silica gel.^[2,3]

F-Thiols can also serve as fluorinated tags in parallel synthesis.^[4] Tagging is achieved by nucleophilic substitution of a halide by the thiol. Detagging is achieved by oxidation of the sulfide to a sulfone followed by nucleophilic substitution by another nucleophile.

Lit.: [1] Zhang, W.; Curran, D. P.; Chen, H.-T. *Tetrahedron* **2002**, 3871; [2] Curran, D. P. *Synlett* **2001**, 1488; [3] Lindsley, C. W.; Zhao, Z.; Leister, W. H.; Strauss, K. A. *Tetrahedron Lett.* **2002**, 43, 6319; [4] Zhang, W. *Org. Lett.* **2003**, 5(7), 1011.

3,3,4,4,5,5,6,6,6-Nonafluoro-1-hexanethiol,¹ ≥99%

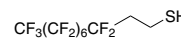
02507
 $C_6H_5F_9S$
 Mw 280.15
 [34451-25-7]



1 g
5 g

3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluoro-1-decanethiol,¹ ≥99%

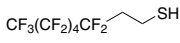
08686
 $C_{10}H_5F_{17}S$
 Mw 480.18
 [34143-74-3]



1 g
5 g

3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluoro-1-octanethiol,¹ ≥99%

02527
 $C_8H_5F_{13}S$
 Mw 380.17
 [34451-26-8]

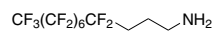


1 g
5 g

2.1.2 F-Amines

4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoro-undecylamine,¹ ≥97%

04636
 $C_{11}H_8F_{17}N$
 Mw 477.16
 [139175-50-1]



1 g
5 g

4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl)benzylamine,¹ ≥97%

07856
 $C_{17}H_{12}F_{17}N$
 Mw 553.26
 [609816-23-1]



1 g
5 g

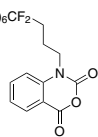
¹ The Rf-tagged nucleophilic scavengers are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

2.2 Rf-tagged Electrophilic Scavengers

2.2.1 F-Isatoic Anhydride

1-(4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoroundecyl)-3,1-benzoxazine-2,4(1H)-dione,¹ ≥97%

07172
 $C_{19}H_{10}F_{17}NO_3$
 Mw 623.26
 [544418-04-4]

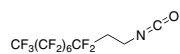


1 g
5 g

2.2.2 F-Ethyl Isocyanate

3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl isocyanate,¹ ≥97%

18486
 $C_{11}H_4F_{17}NO$
 Mw 489.13
 [142010-50-2]

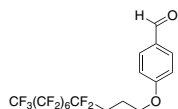
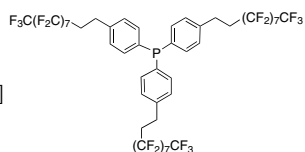
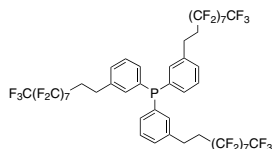
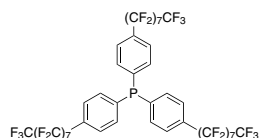
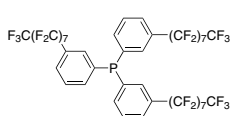
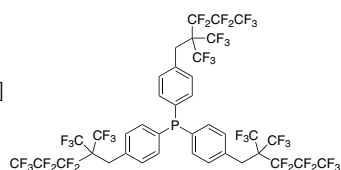
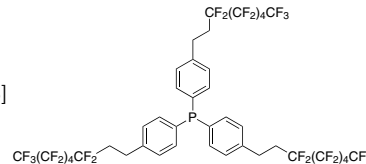
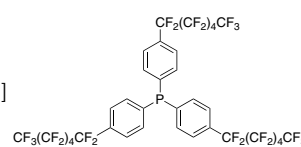
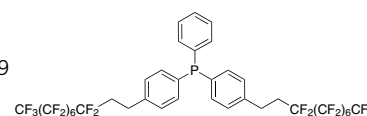
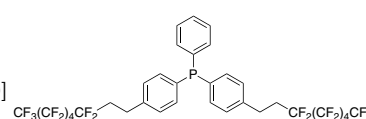
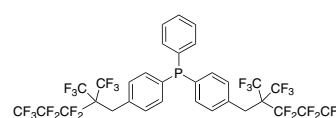
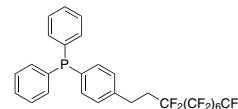


1 g
5 g



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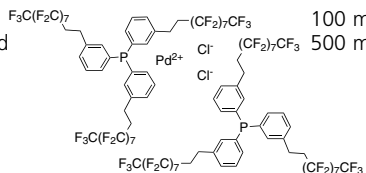
2.2.3 F-Oxybenzaldehyde

4-(4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoro-undecyloxy) benzaldehyde,¹ ≥97%**38456**C₁₈H₁₁F₁₇O₂
Mw 582.25
[494798-73-1]1 g
5 g¹Rf-tagged electrophilic scavengers are products of Fluorous Technologies, Inc. Use of this compound may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539**3. Rf-tagged Ligands and Organometallic Complexes****3.1 F-Triphenylphosphines****Tris[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)phenyl]phosphine, ¹ ≥97%****84928**C₄₈H₂₄F₅₁P
Mw 1600.60
[325459-92-5]1 g
5 g**Tris[3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)phenyl]phosphine, ¹ ≥95%****83934**C₄₈H₂₄F₅₁P
Mw 1600.60
[342889-38-7]1 g
5 g**Tris[4-(heptadecafluorooctyl)phenyl]phosphine, ¹ ≥85%****07086**C₄₂H₁₂F₅₁P
Mw 1516.44
[284472-92-0]1 g
5 g**Tris[3-(heptadecafluorooctyl)phenyl]phosphine, ¹ ≥95%****49822**C₄₂H₁₂F₅₁P
Mw 1516.44
[325459-91-4]1 g
5 g**Tris[4-(3,3,4,4,5,5,5-heptafluoro-2,2-bis(trifluoromethyl)pentyl)phenyl] phosphine, ¹ ≥90%****67301**C₃₉H₁₈F₃₉P
Mw 1258.47
[322647-82-5]1 g
5 g**Tris[4-(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)phenyl]phosphine, ¹ ≥95%****49317**C₄₂H₂₄F₃₉P
Mw 1300.55
[219985-31-6]1 g
5 g**Tris[4-(tridecafluorohexyl)phenyl]phosphine, ¹ ≥90%****12118**C₃₆H₁₂F₃₉P
Mw 1216.39
[193197-68-1]1 g
5 g**Bis[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)phenyl]phenylphosphine, ¹ ≥97%****16367**C₃₈H₂₁F₃₄P
Mw 1154.491 g
5 g**Bis[4-(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)phenyl]phenylphosphine, ¹ ≥90%****19971**C₃₄H₂₁F₂₆P
Mw 954.46
[290827-94-0]1 g
5 g**Bis[4-(3,3,4,4,5,5,5-heptafluoro-2,2-bis(trifluoromethyl)pentyl)phenyl]phenylphosphine, ¹ ≥90%****50476**C₃₂H₁₇F₂₆P
Mw 926.41
[322647-83-6]1 g
5 g**[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl)phenyl] diphenylphosphine, ¹ ≥99%****07026**C₂₈H₁₈F₁₇P
Mw 708.39
[462996-04-9]1 g
5 g¹ Products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

3.2 F-Bis(triphenylphosphine)-Pd(II) dichloride Complexes

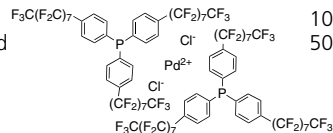
Bis-[tris(3-(1H,1H,2H,2H-perfluorodecyl)-phenyl)-phosphine] palladium(II) dichloride, ≥90%

93521
 $C_{96}H_{48}Cl_2F_{102}P_2Pd$ 100 mg
 Mw 3378.55 500 mg



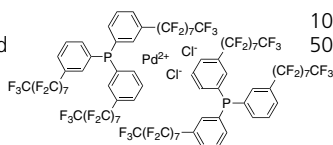
Bis-[tris(3-(heptadecafluorooctyl)-phenyl)-phosphine] palladium(II) dichloride, ≥95%

95421
 $C_{84}H_{24}Cl_2F_{102}P_2Pd$ 100 mg
 Mw 3210.20 500 mg



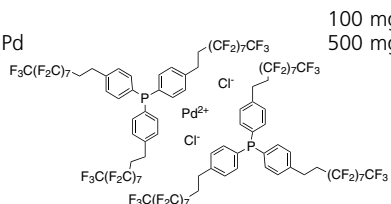
Bis-[tris(4-(heptadecafluorooctyl)-phenyl)-phosphine] palladium(II) dichloride, ≥95%

88508
 $C_{84}H_{24}Cl_2F_{102}P_2Pd$ 100 mg
 Mw 3210.20 500 mg



Bis-[tris(4-(1H,1H,2H,2H-perfluorodecyl)-phenyl)-phosphine] palladium(II) dichloride, ≥80%

95447
 $C_{96}H_{48}Cl_2F_{102}P_2Pd$ 100 mg
 Mw 3378.55 500 mg



3.3 Fluorous Biphasic Catalysis, Kit I: C–C-Coupling

The Fluorous Biphasic Catalysis Kit for C–C-Couplings contains perfluorotagged Pd-catalysts and solvents for up to 10 different catalytic reactions under fluorous biphasic conditions. To get acquainted with this innovative FBC technology our kit provides detailed descriptions of procedures for two C–C-coupling reactions (Suzuki and Stille coupling),^[1,2] all substrates

and reagents necessary for these two model reactions, and eight additional preparations. Analytical methods and spectra are also given as references. FBC technology allows the catalyst to be easily recovered and to be used for further syntheses.

Lit.: [1] Schneider, S.; Bannwarth, W. *Helv. Chem. Acta* **2001**, *84*, 1. [2] Schneider, S.; Bannwarth, W. *Angew. Chem., Int. Ed. Engl.* **2000**, *39*, 4142.

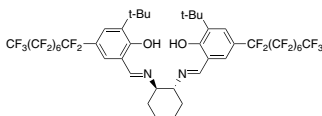
Fluorous Biphasic Catalysis, Kit I: C–C-Coupling

67456 1 kit

3.4 F-Salen Ligand and F-Co-Salen Complex

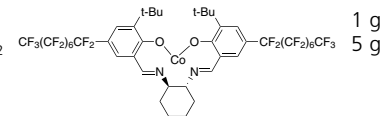
N,N'-Bis[3-tert-butyl-5-(heptadecafluorooctyl)salicylidene]-trans-1,2-cyclohexanediamine,¹ ≥90%

04167
 $C_{44}H_{36}F_{34}N_2O_2$ 1 g
 Mw 1270.71 5 g



N,N'-Bis[3-tert-butyl-5-(heptadecafluorooctyl)salicylidene]-trans-1,2-cyclohexanediamine-cobalt(II),¹ techn.

04168
 $C_{44}H_{34}CoF_{34}N_2O_2$ 1 g
 Mw 1327.63 5 g



¹Products of Fluorous Technologies, Inc. Use of this compound may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539

3.5 Symmetrical Rf-tagged 1,3-Diketone Ligand

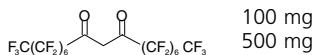
Triacontafluoro-8,10-heptadecanedione has been described as an symmetrical perfluorinated ligand for transition metal catalyzed

oxidations in perfluorinated solvents.^[1]

Lit.: [1] Klement, I.; Lütjens, H.; Knochel, P. *Angew. Chemie, Int. Ed. Engl.* **1997**, *26*, 1454

Triacontafluoro-8,10-heptadecanedione, ≥99.0%

03393
 $C_{17}H_2F_{30}O_2$ 100 mg
 Mw 808.15 500 mg
 [36554-97-9]



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4. Rf-tagged Reagents

4.1 F-DIAD

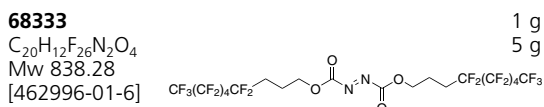
In a typical Mitsunobu reaction between an acidic pronucleophile and an alcohol promoted by diisopropylazodicarboxylate (DIAD) and triphenylphosphine, the desired product is contaminated by reagent derived by-products, phosphine oxide, and hydrazide. F-triphenylphosphine (# 07026, see section 3.1) and F-DIAD (# 68333, below) can be used in traditional solution-phase Mitsunobu chemistry.^[1] The by-products of the reaction are easily separated from the desired product by performing a quick fluorous solid-phase extraction over FluoroFlash[®] silica gel.^[2] The original fluorous azodicarboxylate, F-DEAD, worked well for carboxylic acid and phthalimide pronucleophiles, but

generally less well for phenols and other higher pKa acids. By employing F-DIAD reagent, it is now possible to conduct fluorous Mitsunobu reactions with almost all classes of pronucleophiles including phenols.

Other fluorous phosphine analogs (see section 3.1) with increased number of fluorine atoms may be used. Those with the highest fluorine content are suitable for reactions and separations under biphasic conditions. The phosphine oxide residue may be removed by liquid-liquid extraction as an alternative to SPE.

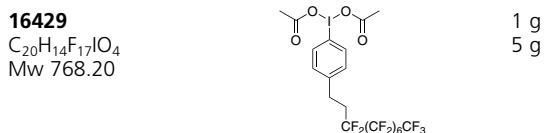
Lit.: [1] Dandapani, S.; Curran, D. P. *Tetrahedron* **2002**, 3855–3864; [2] Curran, D. P. *Synlett* **2001**, 1488.

Bis(4,4,5,5,6,6,7,7,8,8,9,9,9-tridecafluorononyl)azodicarboxylate,¹ ≥90%



4.2 F-DAIB

1-(Diacetoxyiodo)-4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)benzene,¹ ≥90%



¹ The Rf-tagged reagents are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

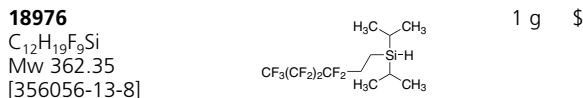
5. Rf-tagged Silanes

F-Silanes are fluorous equivalents to a TIPS group and exhibit properties similar to most silicon protecting groups. Silanes have been used as fluorous tags in both parallel and fluorous mixture synthesis (FMS).^[1,2] Tagging of an alcohol is accomplished by in situ activation of the F-Silane to either the bromide or the triflate followed by addition of the alcohol. The tagged molecule can be manipulated over a number of chemical steps before detagging with fluoride. The tagged intermediates

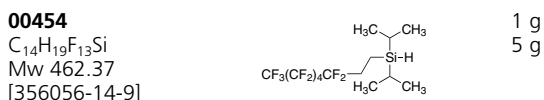
are quickly and easily separated after each step from organic reagents, reactants, or products by fluorous solid-phase extraction (F-SPE) over FluoroFlash[®] Silica Gel.^[3]

Lit.: [1] Luo, Z. Y.; Zhang, Q.; Oderaotoshi, Y.; Curran, D. P. *Science* **2001**, 291, 1766; [2] Zhang, W.; Luo, Z.; Chen, C. H.; Curran, D. P. *J. Am. Chem. Soc.* **2002**, 124, 10443; [3] Curran, D. P. *Synlett* **2001**, 1488.

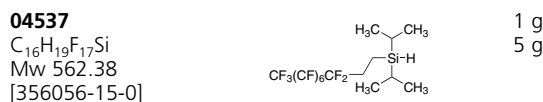
Diisopropyl(3,3,4,4,5,5,6,6,6-nonafluorohexyl)silane,¹ ≥95%



Diisopropyl(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)silane,¹ ≥95%



Diisopropyl(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)silane,¹ ≥95%



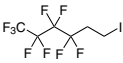
¹ The Rf-tagged silanes are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

6. Rf-tagged Building Blocks and Precursors


6.1 Rf-tagged Alkyl Iodides

6.1.1 F-Ethyl Iodide

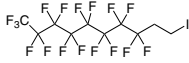
1,1,1,2,2,3,3,4,4-Nonafluoro-6-iodohexane, ≥97%

07387		5 g
C ₆ H ₄ F ₉ I		25 g
Mw 373.99		
[2043-55-2]		

1,1,1,2,2,3,3,4,4,5,5,6,6-Tridecafluoro-8-iodooctane, ≥95.0%

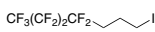
77309		5 mL
C ₈ H ₄ F ₁₃ I		25 mL
Mw 474.00		
[2043-57-4]		

1,1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8-Heptadecafluoro-10-iododecane, >95.0%

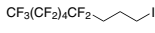
80219		5 g
C ₁₀ H ₄ F ₁₇ I		25 g
Mw 574.02		100 g
[2043-53-0]		

6.1.2 F-Propyl Iodide

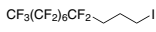
4,4,5,5,6,6,7,7,7-Nonafluoroheptyl iodide,¹ ≥97%

52961		1 g
C ₇ H ₆ F ₉ I		5 g
Mw 388.02		
[183547-74-2]		

4,4,5,5,6,6,7,7,8,8,9,9,9-Tridecafluorononyl iodide,¹ ≥97%

16548		1 g
C ₉ H ₆ F ₁₃ I		5 g
Mw 488.03		
[89889-20-3]		

4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoro-undecyl iodide,¹ ≥99%

68794		1 g
C ₁₁ H ₆ F ₁₇ I		5 g
Mw 588.04		
[200112-75-0]		

¹ The F-propyl-iodides are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

6.2. Rf-tagged Bromobenzene

1-Bromo-4-(heptadecafluorooctyl)benzene, ≥97%

40859		1 g
C ₁₄ H ₄ BrF ₁₇		5 g
Mw 575.06		
[206560-77-2]		

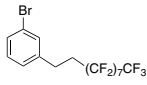
1-Bromo-3-(heptadecafluorooctyl)benzene, ≥95%

76071		1 g
C ₁₄ H ₄ BrF ₁₇		5 g
Mw 575.06		
[325459-90-3]		

1-Bromo-4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)benzene, ≥97%

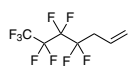
93037		1 g
C ₁₆ H ₈ BrF ₁₇		5 g
Mw 603.11		
[195324-88-0]		

1-Bromo-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)benzene, ≥99%

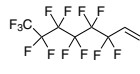
87912		1 g
C ₁₆ H ₈ BrF ₁₇		5 g
Mw 603.11		
[340157-97-3]		

6.3 Rf-tagged Ethylene


1H,1H,2H-Perfluoro-1-hexene

ZONYL®PFBE fluorotelomer intermediate		25 mL
42,150-2		100 mL
C ₆ H ₃ F ₉		
Mw 246.08		
[19430-93-4]		
DuPont product, ®Registered trademark of E.I. du Pont de Nemours & Co., Inc.		

1H,1H,2H-Perfluoro-1-octene, ≥99.0%

37,056-8		5 g
C ₈ H ₃ F ₁₃		25 g
Mw 346.09		
[25291-17-2]		

3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluoro-1-decene, 99 %

37,057-6		5 g
C ₁₀ H ₃ F ₁₇		25 g
Mw 446.11		
[21652-58-4]		



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6.4 Rf-tagged Ethyl-Alcohol

1H,1H,2H,2H-Perfluoro-1-octanol, ≥97.0%

77278

 C₈H₅F₁₃O
 Mw 364.11
 [647-42-7]

 5 mL
 25 mL

1H,1H,2H,2H-Perfluoro-1-decanol, ≥90 %

77263

 C₁₀H₅F₁₇O
 Mw 464.12
 [678-39-7]

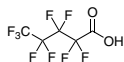
 2.5 g
 10 g

6.5 Rf-tagged Carboxylic Acids and Acid Chlorides

Nonafluorovaleric acid, ≥94 %

Perfluoropentanoic acid

77285

 C₅HF₉O₂
 Mw 264.05
 [2706-90-3]

 5 mL
 25 mL

Tridecafluoroheptanoic acid, ≥95.0 %

77271

 C₇HF₁₃O₂
 Mw 364.06
 [375-85-9]

 5 mL
 25 mL

Tridecafluoroheptanoyl chloride, ≥97.0 %

67162

 C₇ClF₁₃O
 Mw 382.51
 [52447-22-0]

 1 g
 5 g

Heptadecafluorononanoic acid, ≥95.0%

77284

 C₉HF₁₇O₂
 Mw 464.08
 [375-95-1]

 5 g
 25 g

4,4,5,5,6,6,7,7,8,8,9,9,9-Tridecafluorononanoic acid, ≥97.0 %

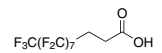
30313

 C₉H₅F₁₃O₂
 Mw 392.11
 [27854-30-4]

 1 g
 5 g

4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoroundecanoic acid, ≥95.0%

05611

 C₁₁H₅F₁₇O₂
 Mw 492.13
 [34598-33-9]

 1 g
 5 g

4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-Heptadecafluoroundecanoyl chloride, ≥97.0%

71941

 C₁₁H₄ClF₁₇O
 Mw 510.57
 [89373-67-1]

 1 g
 5 g

7. Rf-tagged Tin Compounds

Fluorous tagged tin reagents perform the same chemistry as conventional compounds, while also featuring facile purification through fluorous methods.^[1-4] The use of fluorous tin hydride in reductive radical cyclizations illustrates many of the features of this branch of fluorous chemistry. In general, the substrate and the product are organic molecules and one of the other reaction components (in this case, the tin hydride) is fluorous. The fluorous component can be used either

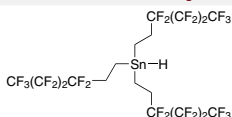
catalytically or stoichiometrically and the reaction and separation stages are decoupled. After standard reactions, members of the tin hydride family with more fluorines can be separated either by liquid-liquid extraction or by solid liquid extraction, while the solid-liquid extraction is preferred for members with fewer fluorines.

Lit.: [1] Curran, D. P.; Hadida, S. *J. Am. Chem. Soc.* **1996**, *118*, 2531; [2] Curran, D. P.; Hadida, S.; Kim, S.-Y.; Luo, Z. *J. Am. Chem. Soc.* **1999**, *121*, 6607; [3] Curran, D. P.; Hadida, S.; Mu He, M. *J. Org. Chem.* **1997**, *62*, 6714; [4] Bucher, B.; Curran, D. P. *Tetrahedron Letters* **2000**, *41*, 9617.

7.1 F-Tin Hydride

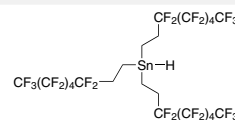
Tris(3,3,4,4,5,5,6,6,6-nonafluorohexyl)tin hydride,² ~90%

06694

 C₁₈H₁₃F₂₇Sn
 Mw 860.96
 [240497-26-1]

 1 g
 5 g

Tris(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)tin hydride,² ~90%

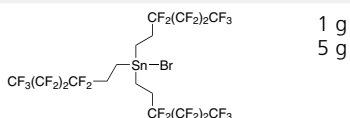
18587

 C₂₄H₁₃F₃₉Sn
 Mw 1161.01
 [175354-32-2]

 1 g
 5 g

7.2 F-Tin Bromide

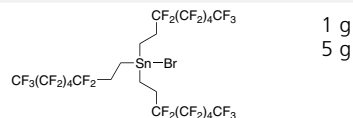
Tris(3,3,4,4,5,5,6,6,6-nonafluorohexyl)tin bromide,² ~ 90%

16445
C₁₈H₁₂BrF₂₇Sn
Mw 939.86
[240497-37-4]



Tris(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)tin bromide,² ≥95%

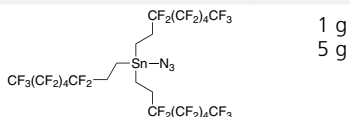
42710
C₂₄H₁₂BrF₃₉Sn
Mw 1239.90
[175354-31-1]



7.3 F-Tin Azide

Tris(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)tin azide,² ≥95%

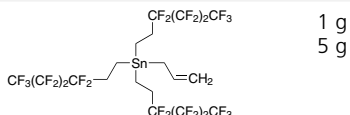
40842
C₂₄H₁₂F₃₉N₃Sn
Mw 1202.02
[201740-73-0]



7.4 F-Allyl Tin

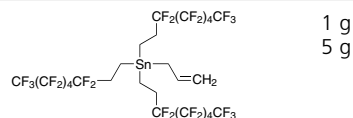
Allyltris(3,3,4,4,5,5,6,6,6-nonafluorohexyl)stannane,² ~90%

43916
C₂₁H₁₇F₂₇Sn
Mw 901.03
[215186-99-5]



Allyltris(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)stannane,² ~90%

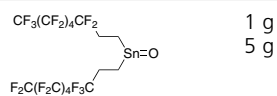
54114
C₂₇H₁₇F₃₉Sn
Mw 1201.07
[192212-66-1]



7.5 F-Tin Oxide

Bis(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)tin oxide,¹ ~90%

43482
C₁₆H₈F₂₆O₂Sn
Mw 828.90
[324063-66-3]



¹ Product of Fluorous Technologies, Inc. Use of this compound may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

² Products of Fluorous Technologies, Inc. Protected by U.S. patents 6,156,896; 5,859,247; and 5,777,127.

8. Fluorous Separation Media

8.1 Rf-Silica Gel

FluoroFlash® Silica Gel¹, particle size ~40 μm

08965 100 g

8.2 Rf-Silica Gel TLC Plates

FluoroFlash® TLC Plates, with F₂₅₄ indicator,¹ dimension 5 cm x 10 cm

16888 10 ea

¹ The fluorous separation media are products of Fluorous Technologies, Inc. Use of these compounds may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539.

FluoroFlash® is a trademark of Fluorous Technologies, Inc.



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9. FluoroFlash® SPE Cartridges for Fluorous Separations

Fluorous Solid Phase Extraction (F-SPE) is used for quick separations of reaction mixtures involving fluorous reagents, protecting groups, tags, and scavengers.^[1-6] FluoroFlash® SPE Cartridges are pre-packed in a variety of formats with a proprietary silica gel bonded with perfluoroalkyl chains. FluoroFlash® Silica Gel separates compounds based primarily on fluorous content. Fluorous molecules are selectively retained while non-fluorous compounds are eluted regardless of polarity. This results in a simple two-step separation of fluorous compounds from non-fluorous compounds. Following completion of a reaction using a fluorous-tagged molecule, the reaction mixture is loaded onto a F-SPE cartridge. Using a fluorophobic wash, typically 80:20 MeOH:H₂O, the non-fluorous organic compounds are washed off the cartridge. The fluorous compounds are then washed off the cartridge using a fluorophilic second wash

such as MeOH, acetone or THF.^[6] The loading capacity for fluorous SPE is typically between 5 and 15% by weight of fluorous silica gel. The cartridge can be regenerated by washing thoroughly with acetone or THF and reused up to 10 times. Multiple fraction collection and analysis are not required as there is one organic wash and one fluorous wash. Due to the large separation, loading levels can be very high. Since the separation process is highly reproducible and functional group independent, it can be easily automated.

Lit. : [1] Curran, D. P. *Synlett* **2001**, 1488; [2] Dandapani, S.; Curran, D. P. *Tetrahedron* **2002**, 58, 3855; [3] Luo, Z.; Williams, J.; Read, R. W.; Curran, D. P. *J. Org. Chem.* **2001**, 4261; [4] Zhang, W. *Org. Lett.* **2003**, 5, 2555; [5] Zhang, W.; Curran, D. P.; Chen, C. *Tetrahedron* **2002**, 58, 3871. Lindsley, C. W.; Zhao, Z.; Leister, W. *Tetrahedron Lett.* **2002**, 43, 4225; [6] Zhang, W.; Luo, Z.; Christine, C.; Curran D. P. *J. Am. Chem. Soc.* **2002**, 124.

FluoroFlash® SPE Cartridges¹

2 grams FluoroFlash® Silica Gel/8 cc tube

14196 20 ea
particle size (Silica Gel) ~40 µm

FluoroFlash® SPE Cartridges¹

5 grams FluoroFlash® Silica Gel/10 cc tube

00866 10 ea
particle size (Silica Gel) ~40 µm

FluoroFlash® SPE Cartridges¹

10 grams FluoroFlash® Silica Gel/60 cc tube

08967 5 ea
particle size (Silica Gel) ~40 µm

FluoroFlash® SPE Cartridges¹

20 grams FluoroFlash® Silica Gel/60 cc tube

08966 2 ea
particle size (Silica Gel) ~40 µm

FluoroFlash® SPE Cartridges¹

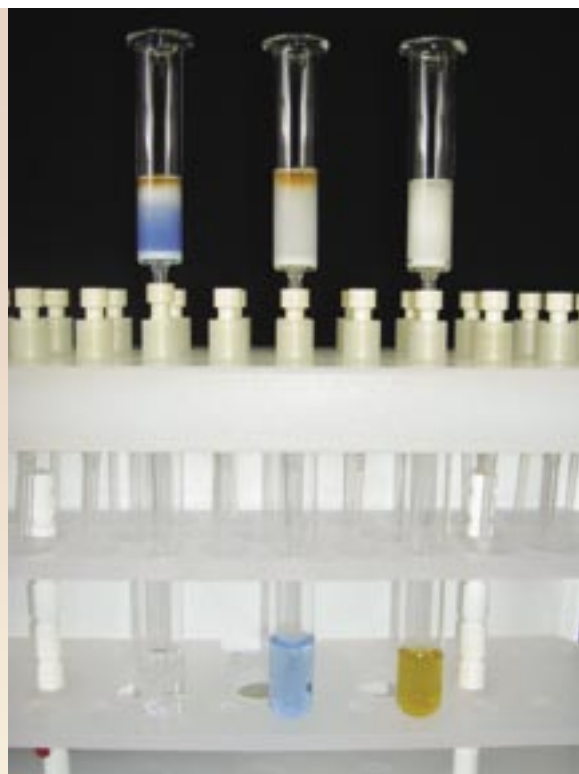
20 grams FluoroFlash® Silica Gel/60 cc tube

06961 5 ea
particle size (Silica Gel) ~40 µm

¹ FluoroFlash® SPE Cartridges are products of Fluorous Technologies, Inc. Use of these products may be protected by U.S. patents 6,156,896; 5,859,247; 5,777,121 and 6,673,539. FluoroFlash® is a trademark of Fluorous Technologies, Inc.

Fluorous Separation Using Solid-Phase Extraction

In the first step of fluorous solid-phase extraction, the reaction mixture is introduced to a cartridge containing fluorous sorbent. The left-hand test tube shows FluoroFlash sorbent immediately after receiving the reaction mixture. The orange-colored compound is a fluorous-tagged dye representing a fluorous-tagged product, and the blue compound is an organic dye simulating impurities. The middle tube shows how the impurities elute following a fluorophobic wash (in this case, MeOH and H₂O in 80:20 ratio), while fluorous-tagged materials are retained on the sorbent through fluorine-fluorine affinity. The third tube illustrates the elution of the fluorous-tagged material following a fluorophilic wash (e.g. MeOH). This simple technique results in purity comparable to chromatography, but much more quickly. Because the separation process is chemistry-independent, it can be easily automated.



10. Fluorous Reversed-Phase Silica Gel for the Immobilization of Rf-tagged Catalysts

Easy handling of the catalyst together with its straightforward recovery and possible reuse are important recommendations in any catalytic reaction. The immobilization of perfluoro-tagged Pd catalysts on fluorosilica gel and the successful application to Suzuki and Sonogashira couplings have been described.^[1] All couplings were performed in organic solvents without using perfluorinated solvents as second liquid phase. The catalysts showed complete conversions and could be recycled without significant decrease of activity. By adding

fluorous reversed-phase silica gel to a solution of a perfluoro-tagged diphenylphosphine Pd(II) dichloride (see section 3.2) in diethyl ether and hexafluorobenzene and evaporating the solvent, an immobilized Pd complex is easily recovered as air-stable, free-flowing powder.

Sigma-Aldrich now offers fluorosilica gel developed for the immobilization of perfluoro-tagged catalysts in three different qualities.

Lit.: [1] Tzschucke, C. C.; Markert, C.; Glatz, H.; Bannwarth, W. *Angew. Chem. Int. Ed.* **2002**, *41*, No 23, 4500.

Silica gel 60 C₈-reversed phase perfluorinated

40915	50 g
particle size 0.035–0.070 mm	250 g

Silica gel 60 C₈-reversed phase perfluorinated end-group silanized

18948	50 g
particle size 0.035–0.070 mm	250 g

Silica gel extra wide pore C₈-reversed phase perfluorinated

18387	10 g
particle size 0.1–0.3 mm (50–140 mesh ASTM)	50 g

11. Solvents for Fluorous Synthesis

Following the definition offered by Gladysz and Curran^[1] a "Fluorous Medium" is "any phase of a perfluoroalkane, perfluorodialkylether, perfluorotrialkylamine, or similar non-polar species, or any similarly-composed micro-environment within a non-fluorous medium that shares key physical properties with these species." Fluorous solvents are used in liquid-liquid extractions to quickly separate fluorosilica compounds from organic compounds in a two phase liquid-liquid extraction, or from organic and inorganic (or water soluble organic) compounds in a three-phase liquid-liquid extraction. Such extractions are readily automated, and can be used to quickly partition reaction mixtures into organic, inorganic and fluorosilica fractions. In many cases, the crude organic products are pure enough to be taken on to the next reaction, and the fluorosilica products can usually be recycled, if desired. In the best cases, only a single separation is needed. With lower partition coefficients, the organic fraction is washed several

times with the fluorosilica solvent. Thanks to the exceedingly low solubilities of organic compounds in fluorosilica solvents, the washing process can be conducted repeatedly without extractive loss of the organic product. Liquid-liquid extractive methods are typically used when the desired product is organic and some other reaction component (reactant, reagent, catalyst, scavenged product) is fluorosilica. Please note that perfluoroarenes are significantly more polar than perfluoroalkanes and preferentially partition into organic media. Therefore they are not fluorosilica under the definition above. Partially fluorinated solvents like (trifluoromethyl)-benzene (# 12811, listed on the next page) provide a homogenous liquid medium for the reaction of fluorosilica and non-fluorous reactants.^[2]

Fluorinert®-fluid PF-5050

Perfluoropentane mixture of isomers	
09973	100 mL
C ₅ F ₁₂	500 mL
[678-26-2]	
* Registered Trademark of 3M Corp.	

Nonafluorobutyl methyl ether, ≥99.0%

HFE-7100	
65139	250 mL
C ₅ H ₃ F ₉ O	1 L

1,1,1,2,3,4,4,5,5,5-Decafluoropentane, ~60 %

94884	100 mL
C ₅ H ₂ F ₁₀	500 mL
[138495-42-8]	

Perfluorohexane FC-72, ~85 %

mixture of isomers	
77273	10 mL
C ₆ F ₁₄	50 mL
[355-42-0]	

Perfluorohexanes 95 %

contains perfluorocyclohexane and ~5% perfluoropentane	
37,924-7	10 mL
C ₆ F ₁₄	50 mL
[355-42-0]	

Perfluoroheptane, ~80%

mixture of isomers	
77272	10 mL
C ₇ F ₁₆	50 mL
[335-57-9]	

Octadecafluorooctane, 98.0%

35,923-8	25 g
C ₈ F ₁₈	100 g
[307-34-6]	

Octadecafluorooctane Fraction, ≥97.0%

Perfluorooctane fraction (~70% Perfluorooctane)	
77286	10 mL
	50 mL
	250 mL

Perfluorononane, 97.0%

Eicosafluorononane	
40,641-4	5 mL
C ₉ F ₂₀	25 mL
[375-96-2]	

Dodecafluorocyclohexane, 97 %

Perfluorocyclohexane	
13,393-0	5 g
C ₆ F ₁₂	
[355-68-0]	



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(Trifluoromethyl)undecafluorocyclohexane, ≥95.0%

Perfluoromethylcyclohexane	
77280	25 mL
C ₇ F ₁₄	100 mL
[355-02-2]	250 mL

Hexadecafluoro-1,3-dimethylcyclohexane, ~80%

Perfluoro-1,3-dimethylcyclohexane	
77268	50 mL
C ₈ F ₁₆	
[335-27-3]	

Octadecafluorodecahydronaphthalene, ≥95.0%

Perfluorodecalin	
77264	10 mL
C ₁₀ F ₁₈	50 mL
[306-94-5]	250 mL

Perfluoro(methyldecalin) 80%

37,243-9	25 g
C ₁₁ F ₂₀	100 g
[51294-16-7]	

Hexafluorobenzene, ≥99.0%

52510	5 mL
C ₆ F ₆	25 mL
[392-56-3]	100 mL

Hexafluorobenzene for NMR-spectroscopy, ≥99.5%

52506	5 mL
C ₆ F ₆	25 mL
[392-56-3]	

(Trifluoromethyl)-benzene, ≥98.0%

Benzotrifluoride	
12811	250 mL
C ₇ H ₅ F ₃	1 L
[98-08-8]	

Heptacosafuorotributylamine

Perfluorotributylamine, Fluorinert® FC-43	
77299	5 mL
C ₁₂ F ₂₇ N	25 mL
[311-89-7]	

*Registered Trademark of 3M Corp.

Pentadecafluorotriethylamine, 96%

Perfluorotriethylamine	
39,715-6	5 mL
C ₆ F ₁₅ N	25 mL
[359-70-6]	

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89744	Trihexyltetradecylphosphonium chloride purum CYPHOS® IL 101 C ₃₂ H ₆₈ ClP Mw 519.31 [258864-54-9]	1.070	5 g; 50 g
96662	Trihexyltetradecylphosphonium bromide purum CYPHOS® IL 102 C ₃₂ H ₆₈ BrP Mw 563.76 -	0.960	5 g; 50 g
50826	Trihexyltetradecylphosphonium decanoate purum CYPHOS® IL 103 C ₄₂ H ₈₇ O ₂ P Mw 655.11 [465527-65-5]	0.895	5 g; 50 g
28612	Trihexyltetradecylphosphonium bis(2,4,4-trimethylpentyl)phosphinate purum CYPHOS® IL 104 C ₄₈ H ₁₀₂ O ₂ P ₂ Mw 773.27 [465527-58-6]	0.895	5 g; 50 g
56776	Trihexyltetradecylphosphonium dicyanamide purum CYPHOS® IL 105 C ₃₄ H ₆₈ N ₃ P -	-	5 g; 50 g
90145	Triisobutylmethylphosphonium tosylate purum CYPHOS® IL 106 C ₂₀ H ₃₇ O ₃ PS Mw 388.54 [344774-05-6]	1.900	5 g; 50 g
50971	Trihexyltetradecylphosphonium bis(trifluoromethylsulfonyl)amide purum CYPHOS® IL109 C ₃₄ H ₆₈ F ₆ NO ₄ PS ₂ Mw 764.00 [460092-03-9]	-	5 g; 50 g
40573	Trihexyltetradecylphosphonium hexafluorophosphate purum CYPHOS® IL110 C ₃₂ H ₆₈ F ₆ P ₂ Mw 628.82 [374683-44-0]	-	5 g; 50 g
15909	Trihexyltetradecylphosphonium tetrafluoroborate purum CYPHOS® IL111 C ₃₂ H ₆₈ BF ₄ P Mw 570.66 [374683-55-3]	2.075	5 g; 50 g

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38938	Methyl-tri-n-butylammonium methylsulfate BASF Quality, >90% BASIONIC™ ST 62 C ₁₄ H ₃₃ NO ₄ S Mw 311.49 [13106-24-6]	62 °C	-	100 g; 1 kg
05338	1-Ethyl-2,3-dimethylimidazolium ethylsulfate BASF Quality, >95% BASIONIC™ ST 67 C ₉ H ₁₈ N ₂ O ₄ S Mw 250.32 [516474-08-1]	67 °C	-	100 g; 1 kg
38899	1-Butyl-3-methylimidazolium chloride BASF Quality, >95% BASIONIC™ ST 70 C ₈ H ₁₅ ClN ₂ Mw 174.67 [79917-90-1]	70 °C	-	100 g; 1 kg
30881	1-Butyl-3-methylimidazolium methanesulfonate BASF Quality, >95% BASIONIC™ ST 78 C ₉ H ₁₈ N ₂ O ₃ S Mw 234.32 [342789-81-5]	75-80 °C	-	100 g; 1 kg
30764	1-Ethyl-3-methylimidazolium chloride BASF Quality, >93% BASIONIC™ ST 80 C ₆ H ₁₁ ClN ₂ Mw 146.62 [65039-09-0]	80 °C	-	100 g; 1 kg
50365	1,2,3-Trimethylimidazolium methylsulfate BASF Quality, >95% BASIONIC™ ST 99 C ₇ H ₁₄ N ₂ O ₄ S Mw 222.26 [65086-12-6]	113 °C	-	100 g; 1 kg
55292	1-Butyl-3-methylimidazolium tetrachloroaluminate BASF Quality, >95% BASIONIC™ AC 01 C ₈ H ₁₅ AlCl ₄ N ₂ Mw 308.01 [80432-09-3]	-10 °C	1.2430	100 g; 1 kg
51059	1-Ethyl-3-methylimidazolium tetrachloroaluminate BASF Quality, >95% BASIONIC™ AC 09 C ₆ H ₁₁ AlCl ₄ N ₂ Mw 279.96 [80432-05-9]	9 °C	1.3040	100 g; 1 kg
56486	1-Ethyl-3-methylimidazolium hydrogensulfate BASF Quality, >95% BASIONIC™ AC 25 C ₆ H ₁₂ N ₂ O ₄ S Mw 208.24 [412009-61-1]	-	1.3673	100 g; 1 kg
57457	1-Butyl-3-methylimidazolium hydrogensulfate BASF Quality, >95% BASIONIC™ AC 28 C ₈ H ₁₆ N ₂ O ₄ S Mw 236.20 [262297-13-2]	28 °C	1.2770	100 g; 1 kg
59760	Methylimidazolium hydrogensulfate BASF Quality, >95% BASIONIC™ AC 39 C ₄ H ₆ N ₂ .H ₂ SO ₄ Mw 180.18 [681281-87-8]	39 °C	1.4835	100 g; 1 kg
40477	Methylimidazolium chloride BASF Quality, >95% BASIONIC™ AC 75 C ₄ H ₆ N ₂ .HCl Mw 118.56 [35487-17-3]	75 °C	-	100 g; 1 kg
51053	1-Ethyl-3-methylimidazolium acetate BASF Quality, >90% BASIONIC™ BC 01 C ₈ H ₁₄ N ₂ O ₂ Mw 170.22 [143314-17-4]	<-20 °C	1.0270	100 g; 1 kg
39952	1-Butyl-3-methylimidazolium acetate BASF Quality, >95% BASIONIC™ BC 02 C ₁₀ H ₁₈ N ₂ O ₂ Mw 198.27 [284049-75-8]	<-20 °C	1.0550	100 g; 1 kg
51682	1-Ethyl-3-methylimidazolium ethylsulfate BASF Quality, >95% BASIONIC™ LQ 01 C ₈ H ₁₆ N ₂ O ₄ S Mw 236.29 [342573-75-5]	<-20 °C	1.2402	100 g; 1 kg
53177	1-Butyl-3-methylimidazolium methylsulfate BASF Quality, >95% BASIONIC™ LQ 02 C ₉ H ₁₈ N ₂ O ₄ S Mw 250.32 [401788-98-5]	<-20 °C	1.2129	100 g; 1 kg
43437	1-Ethyl-3-methylimidazolium thiocyanate BASF Quality, >95% BASIONIC™ VS 01 C ₇ H ₁₁ N ₃ S Mw 169.25 [331717-63-6]	<-20 °C	1.1140	100 g; 1 kg
42254	1-Butyl-3-methylimidazolium thiocyanate BASF Quality, >95% BASIONIC™ VS 02 C ₉ H ₁₅ N ₃ S Mw 197.30 [344790-87-0]	<-20 °C	1.0696	100 g; 1 kg

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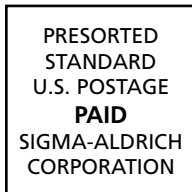
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