



SiliaBond[®]

Reagents



About SiliCycle

Founded in 1995, SiliCycle® Inc. is a worldwide leader in the development, the manufacturing and the commercialization of silica gel products for chromatography, analytical and organic chemistry. With our multi-ton manufacturing capability, we are your partner of choice for all your metal removal, catalysis, synthesis, and purification requirements.

Our business extends to more than fifty countries worldwide and our customer portfolio includes companies in the pharmaceutical, biotechnology industries, contract research and manufacturing organizations as well as university laboratories and hospital research centers.

The mission of SiliCycle is to develop and market innovative silica products of high value to customers and make a technical contribution to their work.

At SiliCycle, we are at the forefront of the chromatography industry, owing to the extraordinary purity of our silica gels and our capacity to rapidly adapt these gels to meet the specific requirements of pharmaceutical professionals and university scientists.

We lead the way in offering innovative products, such as SiliaCat® heterogeneous catalysts, SiliaMetS® Metal Scavengers, SiliaBond® functionalized silica gels, SiliaFlash® Irregular silica gels, IMPAQ® angular silica gels, SiliaSphere™ spherical silica gels, SiliaSep™ flash cartridges, SiliaPrep™ SPEs and Well Plates, SiliaPlate™ TLC plates, and SiliaChrom® HPLC columns.

We offer a wide variety of first-rate Ultra Pure Silica Gels. Our automated manufacturing process, which includes acid washing and multiple analyses, is continuously optimized to ensure high purity and a low percentage of fine particles, thereby guaranteeing optimal performance.

We are committed to provide the highest quality products and services in the industry.



Importance of Quality Control

The Quality Control Department's objective is to provide defect-free products. In light of this goal, we have determined the critical points that need to be addressed for each product line. These points are based on customer's and Account Managers' recommendations as well as on our employees' scientific knowledge.

Each product family has its own quality control procedures, which are strictly adhered to. QC test results are checked and confirmed by the person in charge of them before being cleared for shipping. Complete procedures for each product line are available upon request.

Thus, SiliCycle is committed to high quality standards. In doing so, every product meets the quality specifications our customers demand. All products are shipped with a Certificate of Analysis (CofA) and a sample from every batch is kept for subsequent analysis. If you feel that the product you have received does not meet these specifications, please contact us and we will make sure you are satisfied.

Bare Silica Gel

The backbone of most of SiliCycle's products is SiliFlash F60 (40-63 μm , 60 \AA) silica gel. It provides superior performance for chromatographic applications due to its narrow particle size distribution and high purity.

Before functionalization, every silica is rigorously characterized and analyzed by the procedures below to ensure lot-to-lot reproducibility.

Functionalized Silica Gel

The process for functionalizing the silica is highly dependent on the group being attached. However, it is still possible to functionalize 90% of the surface, verified by ^{29}Si MAS NMR. The remaining 10% of the surface may be endcapped to provide a completely inert support. After being functionalized, the product is submitted to further analysis and quality control as outlined below.

Quality Control	
Type of Analysis	Performed by:
Bare Silica Gel	
Carbon, nitrogen & sulfur content	Elemental analyzer
Total trace metal	ICP-OES
Surface area & porosity	Nitrogen adsorption analyzer
Particle size distribution	Laser light diffraction
Tapped density analysis	Density measurement
Water content	Moisture balance
pH	pH-meter
Functionalized Silica Gel	
Residual solvent content	Moisture balance
Specific reactivity analysis	GC-FID, GC-MS, LC-MS/MS, ICP-OES
Organic function signature	Infrared spectroscopy
Purity analysis	GC-MS



Analysis Descriptions

Elemental Analysis of Organic Compounds

SiliFlash silica gel has a very low organic content. All lots are subjected to elemental analysis to determine the carbon, nitrogen and sulfur levels.

Total Trace Metal Analysis

To improve the quality of the separation, SiliCycle manufactures silica gels with very low traces of metal content. All silica gels are analyzed for more than 45 metals by ICP-OES down to ppm, and reach up to 99.4% silica purity. This removes any issues from metal oxides that may act as Lewis acids and prevents «Tailing» of most polar compounds (*frequently ionizable*) that can be caused by silica with a high metal content.

Surface Area and Porosity Analysis

The efficiency and reliability of silica gel depend on its surface condition. We use the Brunauer, Emmet, and Teller analysis to determine the surface area, and the Barret-Joyner-Hatenda method to determine the pore diameter and pore volume. A larger surface area results in more contact or interaction with the analyte, thereby increasing the segregation of different products. Pore diameter and pore volume permit semi-exclusion chromatography where smaller molecules fit into pores more easily than larger ones. This justifies the use of several types of silica to achieve better discrimination in chromatographic separations.

Particle Size Distribution Analysis

Particle size distribution is determined by laser diffraction. Usually, more than 90% of the silica gel is kept within the appropriate range.

Water Content Analysis (*silica gel activity*)

The amount of water on the silica's surface affects chromatographic performance. An anhydrous silica gel will be extremely polar, while a wetted one will be considerably less polar. Every batch is carefully adjusted to a specific percentage of water content.

pH Analysis

The pH can increase the retention of some ionizable compounds. However, some products can become hydrolyzed or rearranged when in contact with acidic silica. A neutral pH, with a range between 6.5 and 7.5, is the most important factor in determining the reliability and inert behavior of the silica. This pH test involves suspending the silica gel in pure water (5% w/w).



SiliaBond Reagents

Amide Coupling Reagents

The amide bond is the defining molecular structure of proteins and peptides. In addition, a report estimates that as many as 25% of all synthetic pharmaceutical drugs contain an amide group.¹ Therefore, there is an ongoing scientific endeavor to develop efficient amidation methodologies.² Usually, the amide bond formation relies on the use of an excess of toxic coupling reagents such as carbodiimides or supernucleophiles. These chemicals produce a large amount of by-products, which tends to complicate the isolation and purification of the desired amide product.

The use of a reagent linked to an insoluble material has become a widely used tool since the introduction of the solid-phase synthesis concept.³ Solid-phase reagents are valuable for amide coupling with a carboxylic acid because of the decrease of unwanted side products. Other advantages to using solid-supported reagents include improved stability, toxic chemical immobilization, the ability to run multiple transformations in a single pot, and the flexibility to use both batch reactions and flow chemistry.

¹ *J. Comb. Chem.* **1999**, *1*, 55.

² *Tetrahedron* **2005**, *61*, 10827.

³ *J. Am Chem Soc.* **1963**, *85*, 2149.

SiliaBond Carbodiimide (R70530B)

Loading: 1.0 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Carbodiimide (Si-DCC)

1,3-Dicyclohexylcarbodiimide (DCC) has arguably become the most commonly used reagent in peptide synthesis and other amide bond-forming reactions of primary and secondary amines with carboxylic acids.¹ The major drawback associated with using DCC is the formation of the urea by-product (DCU) which remains in solution and requires additional purification steps to remove. However, by using covalently bonded DCC on silica, it is possible to avoid problematic purifications. Only a simple filtration step is needed to remove the unwanted DCU.

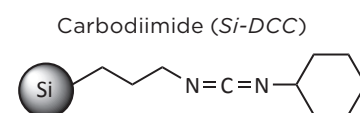
¹ *Chem. Rev.* **1981**, *81*, 589.

Solvent compatibility

- Aprotic Solvent

Prolonged storage

- Keep cool (< 8 °C) and dry, store under argon



SiliaBond Ethyl-Dimethylamino Carbodiimide (EDC) (R70630B)

Loading: 0.8 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Ethyl-Dimethylaminopropyl Carbodiimide (Si-EDC)

A recent literature review shows that 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC) has become recognized as one of the best reagents for amide coupling reactions. Unfortunately, using the EDC basic tertiary amine results in the formation of urea, which has to be separated from the product by acidic aqueous extractions.¹ By attaching EDC to silica, it is possible to avoid this potentially problematic work-up without sacrificing the useful carbodiimide reactivity. In fact, SiliaBond EDC behaves in a similar fashion as EDC in solution, but the by-product remains on the solid support.

¹ *The Peptides: Analysis, Synthesis, Biology; Academic: New York*, **1979**, *1*, 241.

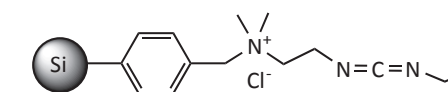
Solvent compatibility

- Aprotic Solvent

Prolonged storage

- Keep cool (< 8 °C) and dry, store under argon

Ethyl-Dimethylaminopropyl Carbodiimide (Si-EDC)



SiliaBond Dichlorotriazine (R52230B)

Loading: 0.7 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Dichlorotriazine (Si-DCT)

2,4,6-Trichloro[1,3,5]triazine (cyanuric chloride) has been used as a versatile reagent in alkyl chloride and acid chloride synthesis. This triazine has been especially useful as a coupling reagent for amide selective formation.¹ However, cyanuric chloride is toxic, corrosive, and a severe eye, skin and respiratory tract irritant. By anchoring cyanuric chloride on a silica matrix, it is now possible to use this valuable reagent without worrying about its toxicity profile. SiliaBond DCT reacts in a similar manner as cyanuric chloride. In addition, excess reagent and by-product elimination is reduced to a simple filtration, which is particularly useful for products where toxicity is a concern such as in the synthesis of active pharmaceutical ingredients (API).

¹ *J. Org. Chem.* **1997**, *62*, 982.

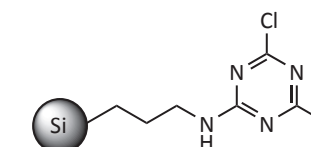
Solvent compatibility

- Aprotic Solvent

Prolonged storage

- Keep cool (< 8 °C) and dry, store under argon

Dichlorotriazine (Si-DCT)



SiliaBond HOBt (R70730B)

Loading: 0.7 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond HOBt (Si-HOBt)

NEW
PRODUCT

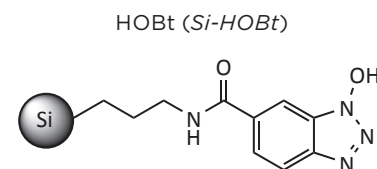
Hydroxybenzotriazole (HOBt) has been used for increasing yield and decreasing racemization during chiral amide synthesis. However, dry HOBt can undergo exothermic decomposition. Bonding HOBt to silica eliminates this risk of explosion. SiliaBond HOBt can be easily activated and should ideally be used with a base such as N,N-diisopropylethylamine in the same condition as in homogeneous solution. Moreover, this supported reagent can be reused a few times without adversely affecting its performance.

Solvent compatibility

- Aprotic Solvent

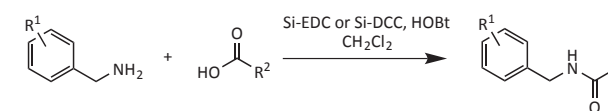
Prolonged storage

- Keep cool (< 8 °C) and dry, store under argon



Synthesis of Capsaicin Analogues

Capsaicin's potential clinical use as an analgesic and peripheral anti-inflammatory effects, as well as the discovery of an ultra-potent analogue (*resiniferatoxin*) has attracted significant interest in finding capsaicin synthesis routes.



General Procedure

The acid (0.5 mmol) was placed in an oven-dried reaction vial with anhydrous CH₂Cl₂ (10 mL) under N₂. The HOBt (1.0 mmol) and the SiliaBond Carbodiimide or SiliaBond EDC were added to the solution, which was then stirred briefly (5 min). The amine (0.5 mmol) was then added to the reaction tube, and the mixture was then stirred for 16 h at room temperature. Finally, the reaction was followed by GC-MS.

Capsaicin Analogues Reaction Results

Entry	Product	Yield ^a (Purity ^b)	
		Si-DCC	Si-EDC
1		99% (> 98%)	81% (> 98%)
2		98% (> 98%)	88% (95%)
3		99% (> 98%)	99% (> 98%)
4		98% ^c	98% ^c

^aYield calculated in crude product, ^bPurity determined by GC-MS, ^cYield determined by GC-MS

Amine Protection Using Benzylcarbamate Group

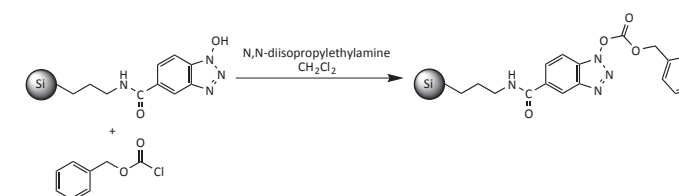
Benzylcarbamate groups are one of the most used amine protecting functions because of the easy deprotection by hydrogenolysis. SiliaBond HOBt, as a key reactive, facilitates the protection manipulation and can be reused a few times without loss of reactivity.

General Procedure

SiliaBond HOBt (1 g or 1 eq.) was introduced in a flask (oven-dried) containing anhydrous CH₂Cl₂. Benzylchloroformate (4 eq.) was added to the suspension, followed by N,N-diisopropylethylamine 4 eq. The reaction mixture was stirred for 60 minutes at room temperature. Then, the suspension mixture was filtered, and washed with CH₂Cl₂ (2 x 10 mL), and the SiliaBond HOBt was oven-dried.

The dried, activated SiliaBond HOBt was placed in a flask containing anhydrous CH₂Cl₂ under N₂. To this suspension, 0.8 eq. of amine was added, and the reaction mixture was stirred for 4 to 16 h at room temperature. The reaction suspension was filtered and washed with CH₂Cl₂ (2 x 10 mL).

Activation Reaction



Activation and recycling Results

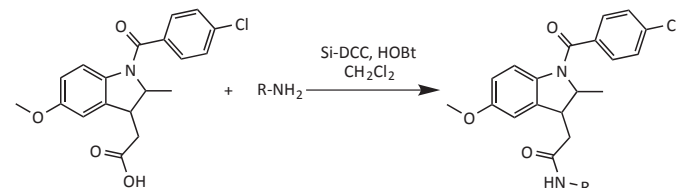
Entry	Yield ^a
Activation	96%
1 st Recycling	86%
2 nd Recycling	95%
3 rd Recycling	96%

^aConversion determined by GC-MS

Synthesis of Amide Derivatives of Indomethacin

A report¹ has shown that indomethacin primary and secondary amide analogues are potent compounds for human COX-2 specific inhibition. SiliaBond Carbodiimide can be used as a key reagent in its synthesis.

¹ *J. Med. Chem.* **2000**, 2860.



General Procedure

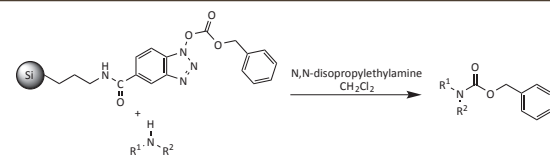
The indomethacin (0.56 mmol) was placed in an oven-dried reaction vial in anhydrous dichloromethane (5 mL) under N₂. HOBT (0.95 mmol) and the SiliaBond Carbodiimide (1.12 mmol) were added, and the mixture was stirred briefly (5 minutes). Then, the amine (0.56 mmol) was added to the vial, and the reaction was stirred at room temperature for 16 h. Then, the crude product was directly purified on a short plug of silica gel (hexane/EtOAc 1/1) to yield pure amide.

Amide Derivatives of Indomethacin Results

Entry	Amine	Yield ^a
1		90%
2		82%
3		94%
4		78%

^aConversion determined by GC-MS

Amine Protection Reaction



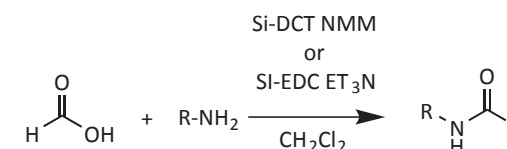
Amine Protection Results

Entry	Product	Conversion ^a
1		98% (4 h)
2		94% (4 h) 96% (16 h) 86% (16 h) ^b
3		81% (16 h)
4		93% (4 h) 98% (16 h)
5		98% (4 h)
6		93% (16 h)

^aConversion determined by GC-MS, ^bPolymer HOBT

Synthesis of Formylated Amino Acids

N-formylamino acid esters are useful derivatives for preparing selected N-formylamino acids, incorporating polyfunctional amino acids into peptides, and for other useful starting material preparation. Formylated amino acids have been prepared in high yields by using SiliaBond Dichlorotriazine (DCT) and SiliaBond Ethyl-Dimethylaminopropyl Carbodiimide (EDC).



General Procedure

Formic acid (0.90 mmol) was placed in an oven-dried reaction vial in anhydrous CH₂Cl₂ (10 mL) under N₂. To this solution was added triethylamine (0.90 mmol) and either the SiliaBond EDC (2.25 mmol) or N-methylmorpholine (0.90 mmol) and SiliaBond DCT (2.25 mmol). Then, the mixture was stirred briefly (5 minutes). The amine (0.45 mmol) was then added to the vial and the reaction was stirred at room temperature for 16 h. Conversion to the desired formamide was followed by GC-MS. Upon completion, the SiliaBond EDC or SiliaBond DCT was filtered and washed with 2 x 10 mL of CH₂Cl₂. Evaporation of the solvent yielded the desired product.

Synthesis of Formylated Amino Acids Results

Entry	Product	Conversion ^a	
		Si-DCT	Si-EDC
1		99%	93%
2		99%	100%
3		99%	99%
4		98%	95%

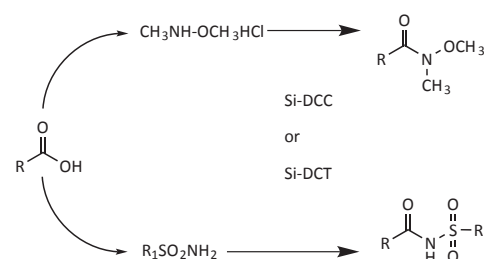
^aConversion determined by GC-MS

Weinreb and Acylsulfonamide Synthesis

Weinreb synthesis is a reaction often used in medicinal chemistry to produce amides. These functional groups are present in natural products and can be reliably reacted to form new carbon-carbon bonds or converted to other functions. In normal conditions, Weinreb synthesis can tolerate a large variety of functional groups such as N-protected amines, sulfonates, alpha-beta saturation and silyl ethers.

Weinreb Synthesis Results			
Acid	Amine	Yield (Purity) ^a	
		Si-DCC	Si-DCT
Benzoic Acid	N,O-Dimethylhydroxylamine Hydrochloride	99% (96%)	96% (94%)
t-Cinnamic Acid		87% (95%)	82% (70%)
2-Nitrobenzoic Acid		> 99% (93%)	92% (79%)

^aYield and purity determined by GC-MS



Acylsulfonamide Synthesis Results			
Acid	Sulfonamide	Yield (Purity) ^a	
		Si-DCC	Si-DCT
Benzoic Acid	Benzenesulfonamide	96% (71%)	98% (90%)
	Methanesulfonamide	79% (53%)	71% (82%)

^aYield and Purity determined by GC-MS

SiliaBond Cyanoborohydride for Reductive Aminations

Reductive amination involves the conversion of a carbonyl group, most of the time a ketone or an aldehyde, to an amine by an intermediate imine or iminium. The intermediate imine is reduced by sodium cyanoborohydride. This is known as direct reductive amination, and is carried out with reducing agents that are more reactive toward protonated imines than ketones and are stable under moderately acidic conditions.

General Procedure

To 1 mmol of SiliaBond Cyanoborohydride 5 mL of solvent, 0.5 mmol of aldehydes or ketones and 0.6 mmol of amines were added. The reaction mixture was stirred at room temperature for 16 h. Each solution was then analysed by GC-MS.

SiliaBond Cyanoborohydride (R66730B)

Loading: 1.0 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Cyanoborohydride (Si-CBH)

SiliaBond Cyanoborohydride is the silica-bound equivalent of sodium cyanoborohydride. Bound cyanoborohydride is very useful in reductive amination and in the reduction of imines and aldehydes. Cyanide contamination of the product is a concern, however, when using the solution phase equivalent. This problem is minimized with the use of silica-bound materials since the toxic cyanide residue remains on the silica. To see if any cyanide ion was leaching from the silica, 1 g of SiliaBond Cyanoborohydride was washed in 10 mL of methanol for 24 h. Cyanide strips indicated less than 3 ppm in each test performed. In addition to providing superior conversions, acetic acid was not needed (*eliminating issues with acid labile groups*), the workup required only a filtration, and HCN and NaCN were not liberated during workup.

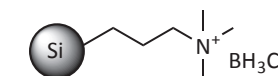
Solvent compatibility

- All solvents, aqueous and organic

Prolonged storage

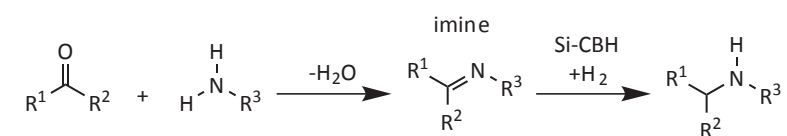
- Keep cool (< 8 °C) and dry, store under argon

Cyanoborohydride (Si-CBH)



SiliaBond Cyanoborohydride for Reductive Aminations

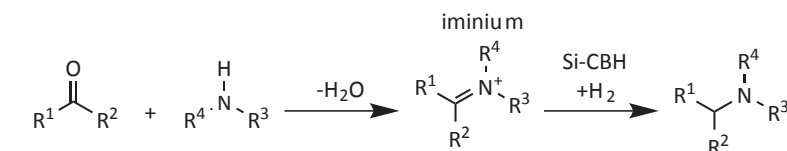
Reduction of Primary Amines



Reduction of Primary Amine Results								
1° Amine	Carbonyl	Conditions (RT 16 h) Product	Acetonitrile		Ethanol		Methylene Chloride	
			Conversion Product (%) ^a	Imine (%) ^b	Conversion Product (%) ^a	Imine (%) ^b	Conversion Product (%) ^a	Imine (%) ^b
			27	25	64	11	69	12
			97	0	95	5	92	8
			92	0	84	7	78	9
			61	20	71	23	73	24
			92	2	83	17	81	13
			88	3	90	7	91	6
			66	21	97	0	100	0
			91	5	93	5	93	6
			90	0	92	6	86	7

^aConversion determined by GC-MS, ^bUnreacted imine was determined by GC-MS

Reduction of Secondary Amines



Reduction of Secondary Amine Results								
2° Amine	Carbonyl	Conditions (RT 16 h) Product	Acetonitrile		Ethanol		Methylene Chloride	
			Conversion Product (%) ^a	SM ^c (%) ^b	Conversion Product (%) ^a	SM ^c (%) ^b	Conversion Product (%) ^a	SM ^c (%) ^b
			90	2	71	0	91	0
			92	5	79	17	93	3
			79	8	79	21	93	2
			94	6	67	0	79	0
			77	23	77	20	87	3
			70	25	61	26	44	2
			97	3	80	0	83	1
			85	15	69	19	88	6
			81	9	70	21	55	2

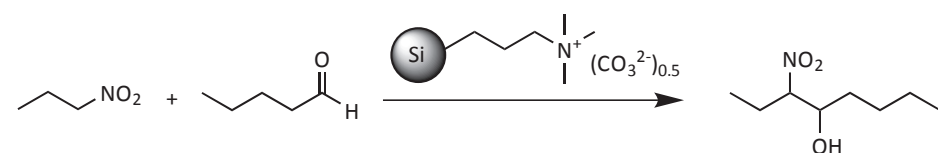
^aConversion determined by GC-MS, ^bUnreacted imine was determined by GC-MS, ^cStarting Material

SiliaBond Carbonate for Henry Reactions

The Henry reaction is commonly used to form carbon-carbon bonds by addition of nitroalkanes over aldehydes. This reaction is a useful technique in organic chemistry due to the synthetic utility of its corresponding products, as they can be easily converted to other useful synthetic intermediates such as nitroalkenes by dehydrogenation, alpha-nitro ketones by oxidation and β -amino alcohols by reduction. Usually, the Henry reaction is carried out in presence of bases in homogeneous solution, giving low yield due to side reactions such as retroaldol and Cannizzaro reactions.

General Procedure

1-nitropropane (1 eq.) was added to a solution containing THF (5 mL) and valeraldehyde (1 eq.). SiliaBond Carbonate (0.1 eq.) was added, and the mixture was stirred at room temperature for 6 h. The reaction mixture was then filtered and washed with THF and the crude product was evaporated. Finally, pure product was obtained after flash chromatography purification using a mix of hexane/ethylacetate (80/20).



Henry Reaction Results

Entry	Solvent	Reaction Conditions	Conversion ^a
1	THF	0.1 eq. Si-CO ₃ room temperature, 6 h	92% (83%) ^b
2	CH ₂ Cl ₂		76%
3	Ethanol		90%
4	Propanol		95%
5	None		92%
6	THF	0.1 eq. Si-CO ₃ μ wave 100 W, 100°C 10 min	89%

^aConversion determined by GC-MS, ^bPurity determined from the isolated product

SiliaBond Carbonate (R66030B)

Loading: 0.7 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Carbonate (Si-CO₃)

Used as a heterogenous catalyst in the Henry reaction, SiliaBond Carbonate is replacing the use of expensive and toxic heterogeneous catalysts. SiliaBond Carbonate in catalytic amounts drive the reaction forward to high yield with or without solvent.

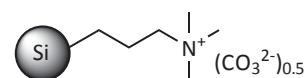
Solvent compatibility

- Aprotic solvents

Prolonged storage

- Keep dry

Carbonate (Si-CO₃)



SiliaBond DMAP for Baylis-Hillman and Acylation Reactions

Baylis-Hillman Reaction

Coupling of activated alkenes, generally alpha, 1-beta-unsaturated, with aldehydes is named the Baylis-Hillman reaction. This reaction is well known for the formation of carbon-carbon bonds under soft conditions and its compatibility with several functional groups. Furthermore, an organic base can be used to catalyze this reaction with similar success to using transition metals.

Acylation Reaction

It is well-known that DMAP used as a catalyst increases speed and yield of alcohol and phenol acylations over acetic and benzoic anhydrides.

SiliaBond DMAP (R75530B)

Loading: 0.8 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond DMAP (Si-DMAP)

SiliaBond DMAP is the heterogenous catalyst equivalent of 4-dimethylaminopyridine, which is used as a nucleophilic catalyst in a wide variety of reactions such as acylations and Baylis-Hillman reactions. These reactions are well known in organic synthesis and are very useful in various applications. SiliaBond DMAP has an advantage over its free counterpart as it can be removed by a simple filtration.

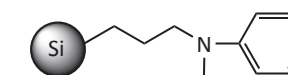
Solvent compatibility

- All organic solvents

Prolonged storage

- Keep cool (< 8 °C) and dry, store under argon

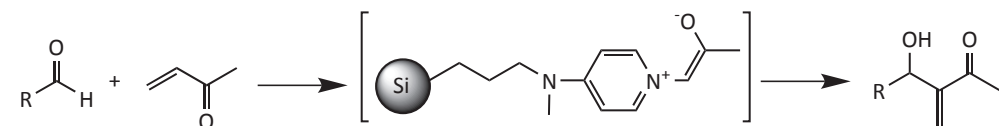
DMAP (Si-DMAP)



SiliaBond DMAP for Baylis-Hillman Reaction

General procedure

Aldehyde (1 mmol) was placed in a flask, and THF, SiliaBond DMAP (0.10 mmol), water and enone (2 mmol) were added. The mixture was stirred at room temperature for 6 to 96 h.



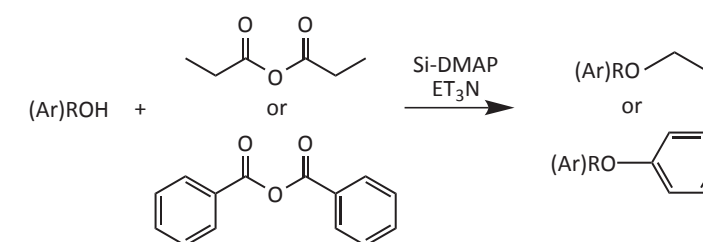
Baylis-Hillman Reaction Results					
Aldehyde	Enone	Conditions	Product	Yield ^a	
				Si-DMAP	Polymer
		THF/H ₂ O (3/1) room temperature, 6 h 10% Si-DMAP		81%	37%
		DMF/H ₂ O (3/1) room temperature, 90 min 10% Si-DMAP		75%	14%
		CH ₂ Cl ₂ room temperature, 24 h 10% Si-DMAP		74%	37%
		No solvent room temperature, 96 h 24% Si-DMAP		71%	58%
		THF/H ₂ O (3/1) room temperature, 96 h 19% Si-DMAP		63%	15%

^aYield determined from the isolated product

SiliaBond DMAP for Acylation Reactions (Acylation of 1-phenyl-1-propanol)

General procedure

A mixture of 2 mmol of alcohol, acetic anhydride (1.3 eq.), triethylamine (1.5 eq.), and 5% SiliaBond DMAP in 5 mL CH₂Cl₂ was stirred at room temperature for 90 min. The reaction was quenched by the addition of 0.5 mL of methanol, diluted with Et₂O, and washed twice with saturated aqueous NaHCO₃ and once with brine. After drying over Na₂SO₄, the solution was filtered and evaporated to give a colorless oil in quantitative yield.



Acylation Results				
Alcohol	Catalyst	Anhydride	Reaction Conditions	Conversion ^a
	None	1.4 eq. Ac ₂ O	18 h, CH ₂ Cl ₂ , room temperature	25%
	5% Si-DMAP	1.2 eq. Ac ₂ O	2 h, CH ₂ Cl ₂ , room temperature	> 98%
	None	1.3 eq. Bz ₂ O	24 h, CH ₂ Cl ₂ , room temperature	11%
	5% Si-DMAP	1.3 eq. Bz ₂ O	24 h, CH ₂ Cl ₂ , room temperature	91%
	None	1.3 eq. Ac ₂ O	18 h, CH ₂ Cl ₂ , room temperature	50%
	5% Si-DMAP	1.3 eq. Ac ₂ O	40 min, CH ₂ Cl ₂ , room temperature	> 98%
	None	1.3 eq. Bz ₂ O	18 h, CH ₂ Cl ₂ , room temperature	29%
	5% Si-DMAP	1.3 eq. Bz ₂ O	2 h, CH ₂ Cl ₂ , room temperature	91%
	None	1.3 eq. Ac ₂ O	19 h, CH ₂ Cl ₂ , room temperature	18%
	5% Si-DMAP	1.3 eq. Ac ₂ O	40 min, CH ₂ Cl ₂ , room temperature	> 98%
	None	1.3 eq. Bz ₂ O	24 h, CH ₂ Cl ₂ , room temperature	6%
	5% Si-DMAP	1.3 eq. Bz ₂ O	24 h, CH ₂ Cl ₂ , room temperature	88%
	None	1.3 eq. Ac ₂ O	3 h, CH ₂ Cl ₂ , room temperature	89%
	5% Si-DMAP	1.3 eq. Ac ₂ O	25 min, CH ₂ Cl ₂ , room temperature	> 99%
	None	1.3 eq. Bz ₂ O	4 h, CH ₂ Cl ₂ , room temperature	63%
	5% Si-DMAP	1.3 eq. Bz ₂ O	4 h, CH ₂ Cl ₂ , room temperature	94%
	None	1.3 eq. Ac ₂ O	24 h, PhH, 80 °C	49% ^b
	5% Si-DMAP	1.3 eq. Ac ₂ O	24 h, PhH, 80 °C	80% ^b

^aConversion determined from the isolated product, ^bDetermined by GC-FID

SiliaBond Tonic Acid in Fischer-Speier Esterifications

The Fischer-Speier reaction is a classic organic process where a carboxylic acid is reacted with an alcohol in the presence of an acidic catalyst to form an ester. All carboxylic acids and only primary and secondary aliphatic alcohols can be used in this reaction. The most commonly used catalysts for this reaction are highly toxic such as H_2SO_4 , tosic acid and scandium triflate. Also, a large excess of one of the reagents is used to push the equilibrium towards the product.

SiliaBond Tonic Acid (R60530B)

Loading: 0.8 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Tonic Acid (Si-SCX)

SiliaBond Tonic Acid is in a class of strong acids used in different fields of synthetic organic chemistry. The aromatic ring makes it slightly more acidic than other supported sulfonic acids. It will not dissolve in methanol or any other solvents.

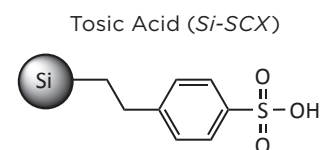
SiliaBond Tonic Acid used as an acid catalyst for Fischer-Speier esterification provides excellent conversion.

Solvent compatibility

- All solvents, aqueous and organic

Prolonged storage

- Keep dry



SiliaBond Tonic Acid for Fischer-Speier Esterifications

General procedure

Method A

1.5 mmol of carboxylic acid was added to a mixture of alcohol (10 mL) and SiliaBond Tonic Acid (0.1 eq.). The reaction mixture was maintained at reflux under magnetic agitation for 16 h.

Method B

In a 250 mL round-bottom flask with a magnetic stirrer and a Dean-Stark apparatus, 16.3 mmol of a carboxylic acid was added to alcohol (4 eq.) and SiliaBond Tonic Acid (0.1 eq.). The mixture was then heated to reflux for 20 to 24 h under magnetic agitation.

Fischer-Speier Esterification Results

Alcohol	Carboxylic Acid	Method	Ester	Conversion ^a
Ethanol		A		100%
Methanol		A		98%
Ethanol		A		100%
1-Octanol		A		100%
1-Butanol		A		100% (99%) ^b
3-Methylbutanol		A		100%
Ethanol		A (72 h)		40% ^c
Ethanol		B		94% ^c
Methanol		B		89% ^c

^aConversion determined by GC-MS, ^bSi-SCX reused 3 times, ^cConversion determined from the isolated product

SiliaBond TBD for Williamson Etherifications

The Williamson etherification is a standard reaction to synthesize asymmetric ethers from alcoholates, prepared from primary and secondary alcohols or phenols with base, in the presence of primary alkyl halides. Because of the high reactivity of alcoholates, they need to be produced during the reaction by strong bases.

SiliaBond TBD (R68530B)

Loading: 0.9 mmol/g | Endcapping: Yes | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond TBD (Si-TBD)

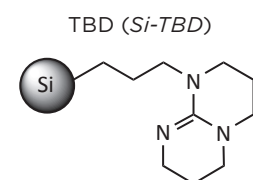
SiliaBond TBD is a silica-bound bicyclic guanidine moiety that is sufficiently basic to deprotonate moderately acidic hydrogens. It is most commonly used in Williamson ether synthesis.

Solvent compatibility

- All solvents, aqueous and organic

Prolonged storage

- Keep cool (< 8°C) and dry, store under argon

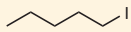
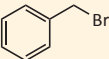


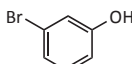
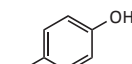
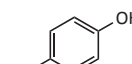
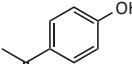
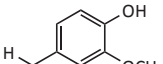
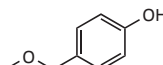
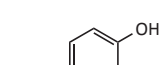


SiliaBond TBD for Williamson Etherifications

General procedure

0.15 mmol of alcohol was added to 4 mL of acetonitrile and SiliaBond TBD (0.3 eq.). The solution was stirred for 1 h at room temperature. Next, 0.12 mmol of the alkyl halide was transferred to the reaction mixture, which was again stirred for 16 h at 60°C. Finally, the mixture was filtered and washed with 2 mL of acetonitrile. Conversion was measured by GC-MS.

Williamson Etherification Results

Alcohol	Alkyl Halide	
		
	83%	89%
	89%	88%
	81%	88%
	80%	80%
	59%	86%
	79%	88%
	87%	94%
	78%	86%
	76%	75%

SiliaBond Aluminum Chloride Used as a Catalyst for Friedel-Crafts Alkylations and Acylations

For decades, sulfonated linear alkylbenzenes (LABs) have been among the most prolific detergents. LAB synthesis is carried out by Friedel-Crafts alkylation of benzene by linear olefins using hydrogen fluoride or aluminum chloride as catalyst. The use of these catalysts presents severe problems, however. For example, aluminum chloride is difficult to separate after reaction and produces a large amount of waste effluent.

SiliaBond Aluminium Chloride (R74530B)

Loading: 1.6 mmol/g | Endcapping: No | Category: Reagent | Format: 5g, 10g, 25g, 50g, 100g, 250g, 500g, 1kg, 10kg, 25kg, ..., Multi-Ton

Description

SiliaBond Aluminum Chloride (Si- $AlCl_x$)

SiliaBond Aluminum Chloride is the silica-supported version of the most widely used Lewis acid, aluminum chloride.¹ It is an effective catalyst for Friedel-Crafts alkylations²⁻⁴ and acylations. It also catalyzes the formation of ethers. The silica supported product has several advantages over the free catalyst.^{5,6}

- It is a milder Lewis acid. $AlCl_3$ is so reactive that it often lacks selectivity and causes the formation of unwanted by-products.
- The steric bulk of the silica reduces over alkylation and increases shelf life.

Execution of the reaction is easier. The reagent is removed by a simple filtration, avoiding the destructive water quench which produces large amounts of hazardous waste.

SiliaBond Aluminum Chloride's activity can be determined by its color. The material should only be used when it's yellow or violet. The product turns white in presence of moisture.

¹ Acc. Chem. Res., 2002, 35, 791

² Org. Process Res. Dev., 1998, 2, 221

³ J. Catal., 2000, 195, 237

⁴ J. Catal., 2000, 195, 412

⁵ Chem. Rev., 2003, 103, 4307

⁶ Tetrahedron, 2003, 59, 1781

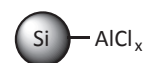
Solvent compatibility

- All anhydrous organic solvents

Prolonged storage

- Keep cool (< 8°C) and dry, store under argon

Aluminum Chloride (Si- $AlCl_x$)

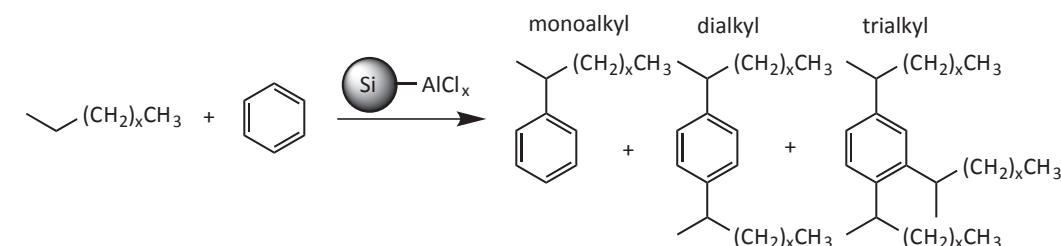


SiliaBond Aluminum Chloride as a Catalyst for Friedel-Crafts Alkylations

General procedure

SiliaBond Aluminum Chloride (0.03 eq.) is stirred into anhydrous benzene (Typical reaction solvent volume: 5 mL/g of SiliaBond Aluminium Chloride). Add the alkene (1.0 eq.) slowly (a small exothermic reaction should be observed).

After the addition is completed, remove the catalyst by filtration.



Friedel-Crafts Alkylation Results

Alkene	Catalyst	Alkene Conversion ^a	Selectivity Towards Alkylbenzene		
			% Mono	% Di	% Tri
1-Hexene	$AlCl_3$	100%	58.6	31.1	10.3
1-Hexene	Si- $AlCl_x$	100%	71.0	28.0	1.0
1-Decene	$AlCl_3$	100%	68.5	22.5	9.0
1-Decene	Si- $AlCl_x$	100%	80.0	20.0	0

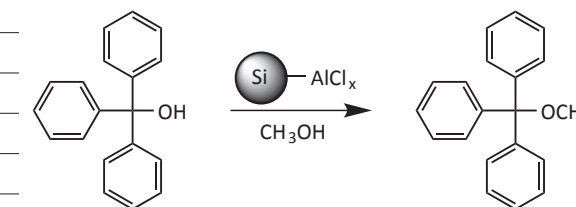
^aConversion determined by GC-MS

SiliaBond Aluminum Chloride as Catalyst for Friedel-Crafts Acylation

Friedel-Crafts Acylation Results

Alcohol	Catalyst	Conversion ^a
Triphenylmethanol	Si- $AlCl_x$	95%
	Polymer- $AlCl_3$	81%
Tert-Butyl Alcohol	Si- $AlCl_x$	60%
	Polymer- $AlCl_3$	0%
Benzyl Alcohol	Si- $AlCl_x$	40%
	Polymer- $AlCl_3$	0%

^aConversion determined by ¹H NMR



SiliaBond Reagents and Scavengers for Typical Coupling Reactions

Coupling Reactions	
Reaction	Reagent / Scavenger
Amide Coupling	
with acid chlorides and amines	SiliaBond Carbodiimide
with acids and amines	SiliaBond Dichlorotriazine SiliaBond Amine (scavenger) - removes excess acid chloride SiliaBond Isocyanate/SiliaBond Tosic Acid - remove excess of amine
using HOBt or pentafluorophenol	SiliaBond Carbonate - removes excess of HOBt
Buchwald Amination	SiliaMetS Metal Scavengers - remove palladium SiliaBond Tosic Acid
Heck Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaMetS Metal Scavengers - remove palladium
Sonogashira Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaMetS Metal Scavengers - remove palladium, copper
Stille Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaMetS Metal Scavengers - remove palladium, tin
Suzuki Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaBond Carbonate - removes excess of boronic acid SiliaMetS Metal Scavengers - remove palladium
Kumada Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaMetS Metal Scavengers - remove metal residue
Negishi Coupling	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst) SiliaMetS Metal Scavengers - remove metal residue

SiliaBond Reagents and Scavengers for Common Organic Reactions

Common Organic Reactions	
Reaction	Reagent/Scavenger
Acylation/Esterification	SiliaBond DMAP SiliaBond TBD
Deprotection of Aromatic Ether	SiliaBond Tosic Acid
Ether formation	SiliaBond Aluminium Chloride (catalyst) SiliaBond Tosic Acid SiliaMetS Metal Scavengers - remove metal catalyst
Fmoc, Bsmoc Deprotection of Amino Acid	SiliaBond Piperazine (reagent / scavenger) - Fmoc deprotection
Friedel-Crafts Alkylation	SiliaBond Aluminium Chloride
Fries Rearrangement	SiliaBond Tosic Acid
Knoevenagel Condensation	SiliaBond Amine SiliaBond Dimethylamine SiliaBond TBD SiliaBond Piperidine SiliaBond Piperazine
Michael Addition	SiliaBond Dimethylamine SiliaBond TBD SiliaMetS Metal Scavengers - remove metal catalyst
Oxidation	
alcohols to acids	SiliaBond Potassium Permanganate
alcohols to ketones or aldehydes	SiliaCat TEMPO SiliaBond Pyridinium Chlorochromate (PCC) SiliaBond Pyridinium Dichromate (PDC)
alkanes	SiliaBond Dimethylamine
Reduction	
with borohydride reducing agents	SiliaBond Tosic Acid - removes excess and spent borohydride
Reductive Amination	SiliaBond Cyanoborohydride SiliaBond Tosic Acid - removes excess of amine
Sulfonamide Synthesis	SiliaBond Dichlorotriazine SiliaBond EDC SiliaBond Amine - removes excess of sulfonyl chloride
Tosylate Formation	SiliaBond Tosyl Chloride
Urea Synthesis	SiliaBond Amine - removes excess of isocyanate
Williamson Ether Synthesis	SiliaBond TBD
Grubbs Metathesis	SiliaMetS Metal Scavengers - remove ruthenium
Sharpless Dihydroxylation	SiliaMetS Metal Scavengers - remove osmium
Catalytic Hydrogenation	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst)/ SiliaMetS Metal Scavengers - remove metal catalysts
Cyanation	SiliaCat DPP-Pd, SiliaCat S-Pd and SiliaCat Pd ⁰ (catalyst)/ SiliaMetS Metal Scavengers - remove metal catalysts
Hydrogenation	SiliaCat Pt ⁰ (catalyst)
Debenzylation of Benzyl protected Groups	SiliaCat Pd ⁰ (catalyst)
Hydrosilylation	SiliaCat Pt ⁰ (catalyst)



Contact Us
Order Now

Ordering Information

Quote Form

General Information

Company:

SiliCycle Customer Number (if known):

Contact Name:

E-mail address:

Tel: Fax:

Address Information

.....

Department:

Address:

ZIP/Postal Code:

Country:

Quote Request		
Part Number	Product Description	Request Quantity

Confirm this request by

- FAX
- E-mail
- Phone

Comments

.....

.....

.....

.....

Information Request Form

<input type="checkbox"/> Metal Scavengers	<input type="checkbox"/> Catalysts	<input type="checkbox"/> Oxidants
Metal of interest:	<input type="checkbox"/> Silia <i>Cat</i> catalysts	<input type="checkbox"/> Silia <i>Cat</i> oxidant
.....	<input type="checkbox"/> Silia <i>Bond</i> catalysts	<input type="checkbox"/> Silia <i>Bond</i> oxidants
.....	<input type="checkbox"/> Silia <i>Cat</i> + Silia <i>Bond</i> catalysts	<input type="checkbox"/> Silia <i>Cat</i> + Silia <i>Bond</i> oxidants
.....		
<input type="checkbox"/> Organic scavengers	<input type="checkbox"/> SiliaBond Reagents	<input type="checkbox"/> Others
<input type="checkbox"/> Nucleophile scavengers	<input type="checkbox"/> Reaction of interest	<input type="checkbox"/>
<input type="checkbox"/> Electrophile scavengers	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Genotoxic scavengers	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Chromatographic phases	<input type="checkbox"/> HPLC Columns	<input type="checkbox"/> Application notes in
<input type="checkbox"/> Reversed phases	<input type="checkbox"/> Reversed phases	<input type="checkbox"/> Bulk
<input type="checkbox"/> Normal phases	<input type="checkbox"/> Normal phases	<input type="checkbox"/> SPE cartridges
<input type="checkbox"/> Fluorous phases	<input type="checkbox"/> Ion exchangers	<input type="checkbox"/> Flash cartridges
<input type="checkbox"/> Ion exchangers	<input type="checkbox"/> Chiral phases	

General Information

Company:

SiliCycle Customer Number (if known):

Contact Name:

E-mail address:

Tel: Fax:

Address Information

.....

Department:

Address:

ZIP/Postal Code:

Country:

Comments

.....

.....

..... Please Copy and Fax this form to SiliCycle Inc. at **418-874-0355**

Order Form

General Information

Company:
 SiliCycle Client Number: Purchase Order Number:
 Contact Name:
 E-mail address:
 Tel: Fax:

Payment Details

Verification Code*

Credit card number: *The 3 last numbers in the back side of your card
 Expiry date:
 Name as it appears on card:
 VISA Master Card Amex

Address Information for the Shipment

Department:
 Address:
 ZIP/Postal Code:
 Country:

SiliCycle Products				
Part Number	Product Description	Packaging (g, Kg, box)	Quantity	Price (USD)

Confirm this request by

- FAX
- E-mail
- Phone

Comments

.....
 Please Copy and Fax this form to SiliCycle Inc. at **418-874-0355**

Ordering Information

How to order

You can order any SiliCycle product on-line through the new SiliCycle e-commerce website: www.silicycle.com.

You can also order any product from this catalog, 365 days or nights a year. We hope you will enjoy this new and friendly way to order SiliCycle products.

Orders can also be placed by phone, fax, mail or e-mail. You will find an order form on page 222 of this catalog for fax (1 418.874.0355) and mail (SiliCycle headquarters address at the bottom of this page) orders. If you prefer, you can reach us by e-mail (info@silicycle.com) or by phone (1 418.874.0054 or Toll free for North America only 1 877.745.4292). Please have the following information on hand:

- Your name
- Company name, billing and shipping address
- Purchase order number
- Credit card information
- Catalog number and product description
- Size, quantity and unit of measure
- E.I.N. or F.I.N .for United States clients

Technical Support

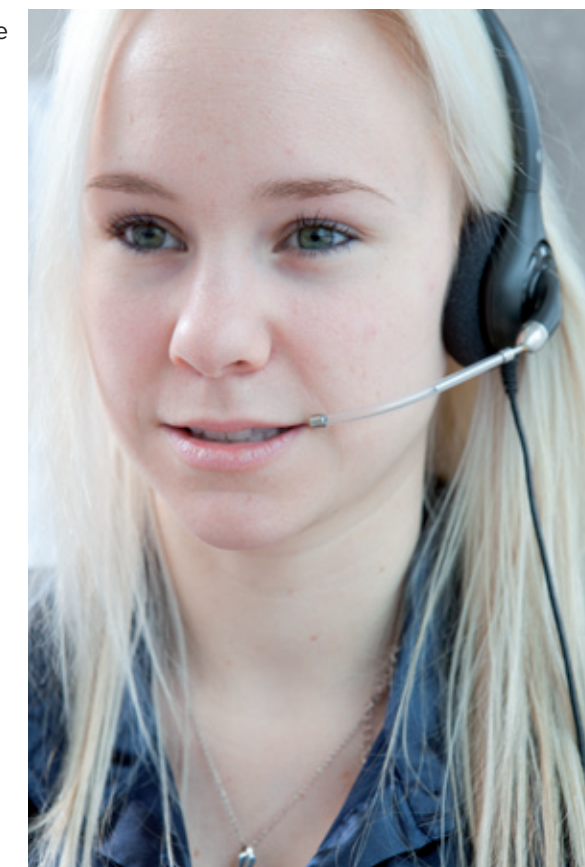
At SiliCycle, we are committed to providing the best technical support possible. Our worldwide Technical Support Group is comprised of a team of highly qualified M.Sc., Engineers and PhD Chemists, Technical Support Professionals and Service Coordinators who are prepared to troubleshoot, answer questions, and provide solutions for your service and applications needs.

In order to better respond to your technical inquiries, feel free to contact us in three different ways:

- E-mail: support@silicycle.com
- Phone: International 1 418.874.0054
- Canada USA 1 877.745.4292 (Toll-Free)
- Online forum at www.SiliCycle.com

SiliCycle headquarters address:

2500, Parc-Technologique Blvd
 Quebec City, Quebec
 G1P 4S6, CANADA



Terms and Conditions

General

Unless otherwise stated, all transactions are expressly subject to these Terms and Conditions. Modifications or additions will be recognized only if accepted in writing by an officer of SiliCycle Inc. (*hereinafter named SiliCycle*), or an officially designated representative. Provisions of Buyer's Purchase Order or other documents that add to or differ from these Terms and Conditions are expressly rejected. No waiver of these Terms and Conditions or acceptance of others shall be construed as failure of the Company to raise objections.

Privacy Policy

Because your clientele is our most vital asset, we take privacy very seriously and won't share your personal information with anyone. Your information is used only to personalize your profile and to facilitate the transaction. You can change or update your information at any time.

Quotation and Published Prices

Quotations automatically expire 30 calendar days from the date issued unless otherwise stated. Quotes are subject to withdrawal with notice within that period. Prices shown on the published price lists and other published literature issued by SiliCycle are not unconditional offers to sell, and are subject to change without notice.

Warranty

SiliCycle guarantees to the original Buyer that the products sold conform to the composition and purity described therein at the time of their shipment. The Buyer's sole remedy in the event that SiliCycle fails to meet said warranty shall be the replacement of the unused portion of the product(s), or if approved by SiliCycle, a refund (*at the purchase price*) provided that the Buyer returns the alleged non-conforming product(s) within 30 days after reception of product(s). SiliCycle makes no other guarantee of suitability for a particular purpose or of the merchantability in the use or handling of the product, and does not accept any liability for consequential, special, indirect or incidental damages resulting therefrom.

Changes

The Buyer may, with the express written consent of SiliCycle, make changes in the specifications for products or work covered by the contract. In such an event, the contract price and delivery dates shall be equitably adjusted. SiliCycle shall be entitled to payment for reasonable profit plus costs and expenses incurred by work and materials rendered unnecessary as a result of such changes and for work and materials required to effect said changes.

If the Buyer has made a mistake on his/her purchase order, and the material has already been shipped and received, SiliCycle may approve the exchange of said material (*if price is identical*); however the Buyer will be responsible for all shipping costs. See return authorization policy section on the next page to obtain a return merchandise authorization form prior to returning goods.

Cancellation

Undelivered parts of any order may be cancelled by the Buyer only with the written approval of SiliCycle. If the Buyer makes an assignment for the benefit of creditors, or in the event that SiliCycle, for any reason feels insecure about Buyer's willingness or ability to perform, SiliCycle shall have the unconditional right to cancel the sales transaction or demand full or partial payment.

In the event of any cancellation of this order by either party, the Buyer shall pay SiliCycle for reasonable costs and expenses incurred by the SiliCycle prior to receipt of the cancellation notice, plus SiliCycle's usual rate of profit for similar work.

Taxes

The Company's prices do not include any applicable sales, goods and services, use, excise or similar taxes and the amount of any such tax SiliCycle may be required to pay or collect will be added to each invoice and paid by the Buyer.

Terms of Payment

All merchandise purchased remains the property of SiliCycle until such time as all invoices for the merchandise have been paid in full. Except for purchases paid online, or unless explicitly stated elsewhere in writing, terms are cash net 30 days from date of invoice. Additional fees of 2% per month (26.8% per year) will accrue on all accounts past due. If any payment is in default, and it becomes necessary to hire a recovery agency or lawyer, the client accepts to pay, in addition to the outstanding balance, recovery fees equal to 20% of the balance in capital and interests. By reason of the financial condition of Buyer or otherwise, SiliCycle may require full or partial payment in advance.

Certain orders may require a deposit or progressive payments as referenced in the quote. Such deposits may be increased upon receipt of purchase order based upon the Buyer's most current credit rating. Subject to the warranties stated in this policy, all sales are final without right of return.

Return Policy

Our Customer Service Department is available to assist you at any time should a problem arise with your order. Please make sure to inspect your packages immediately upon receipt and notify us within the next two (2) business days of any damage and/or discrepancies. Should a product be sent to you incorrectly, as the result of an error on our part, we will take quick and appropriate action to correct the problem at no charge to you.

In order to maintain the quality of our products and continue to provide competitive prices, some products may not be returned for credit. SiliCycle will not grant credit for:

- (i) Shelf-worn, used or defaced products;
- (ii) Scavengers, reagents, catalysts, or any other bounded silica whose containers have been opened;
- (iii) Products that are personalized or customized;
- (iv) Refrigerated or temperature-controlled products;
- (v) Products that have been discontinued;
- (vi) Products not directly purchased from SiliCycle

Products sold in distribution by SiliCycle will be subject to the Terms and Conditions Policy of the respective manufacturer.

Prior to any return, an authorization and a return material authorization (RMA) number must be obtained from our Customer Service Department. Shipping instructions will also be provided at this point. The RMA will ensure the safe and proper handling of material; it should therefore be referenced on all shipping labels.

The Buyer has 30 days from the issuance of the RMA to return the goods. Returns made without an authorization number will not be accepted and will be returned to the Buyer.

Returns are subject to a 50% restocking and/or disposal fee.

Shipping Policy

SiliCycle uses a two-day or five-day delivery (or equivalent) depending on weight and availability of product. Standard overnight delivery can also be arranged. Freight charges are prepaid and added to the invoice unless special instructions are requested by the customer. These conditions apply to all North American shipments. International delivery delays will vary according to orders and destination countries.

Delivery

Delivery dates indicated in the contract documents are approximate and based on prompt receipt of all necessary information regarding the product covered by the contract. SiliCycle will use reasonable efforts to meet the indicated delivery dates, but cannot be held responsible for its failure to do so.

In the event of any delivery delay caused by the Buyer, SiliCycle will store and handle all items ordered at Buyer's risk and will invoice Buyer for the unpaid portion of the contract price, plus storage, insurance, and handling charges on or after the date on which the product is ready for delivery. The invoice will be payable in full within 30 days from the invoice date, unless otherwise expressly agreed to in writing by SiliCycle.

SiliCycle will not hold orders unless specifically approved. SiliCycle has the right to make partial shipments and bill for those shipments; the buyer will make payment in accordance with the terms mentioned in this policy.

Shipping and Handling Charges

Shipping charges plus the applicable company handling charges will be prepaid and billed as a separate item on the product invoice. Title to the product and risk of loss shall pass to Buyer upon delivery to a carrier.

Application

All products are sold for laboratory or manufacturing uses. Only professional laboratory staff should handle the chemicals.



As a recognized industry leader in the development, manufacturing and commercialization of innovative silica gel products, and with multi-ton manufacturing capability, SiliCycle® is your partner of choice for all your **metal removal**, **catalysis**, **synthesis**, and **purification** requirements.

SiliaMets®
Metal Scavengers



- No leaching: no API contamination
- High selectivity: total recovery of the API
- Very good metal affinity: efficient for a wide range of metal catalysts
- Solvent compatibility: can be used in any any solvents (pH 2 to 12)
- Fast kinetic even at room temperature
- Easily scalable
- Thermally and mechanically stable
- Ease of use and flexible formats
- Cost efficient: low cost per gram of metal scavenged
- Available in large quantities (**multi-ton scale**)

SiliaCat®
Heterogeneous Catalysts



- Wide range of organic coupling and hydrogenation reactions (**Suzuki, Sonogashira, Heck, and Stille**)
- SiliaCat silica-supported catalysts for cleaner products and cleaner waste streams
- Ideal for batch or flowthrough applications
- Cost efficient and highly stable
- Reusable and leach proof
- Available in sizes ranging from grams to multi-kilograms quantities

SiliaBond® C18
Chromatographic Phase



- Unmatched quality and performance
- Very highly hydrophobic C18 phase
- A homogeneous functionalized layer
- A unique grafting method ensuring reproducible results
- An unprecedented endcapping efficiency
- Incomparable lot-to-lot reproducibility
- The quality of a monofunctional C18
- Available in large quantities (**multi-ton scale**)

SiliaBond®
Functionalized Silica Gels



- No leaching (chemical stability)
- Selective nucleophile and electrophile scavengers
- High resolution chromatographic phases
- **Supported reagents** for organic synthesis
- Thermally stable and microwave compatible
- Available in large quantities (**multi-ton scale**)

SiliaChrom®
HPLC Columns



- Broad pH range (0,8-12,0)
- High surface coverage
- Wide variety of chemistries available
- Excellent column efficiency
- Long column lifetime
- Low bleed

SiliaPlate™
TLC Plates



- Analytical and preparative TLC plates
- Different sizes and choice of backings
- Normal, reversed and specialty phases

SiliaFlash®
Irregular Silica Gels



- High purity irregular Gel
- Tight particle size distribution
- Very low level of fines
- Neutral pH, low metal content, and controlled water level content
- Lot-to-lot reproducibility

SiliaSep™
Flash Cartridges



- High resolution & reproducibility
- Ultra high performance cartridges available (**SiliaSep HP**)
- Compatible with all commercial systems
- Reversed and specialty phases available

SiliaSphere™
Spherical Silica Gels



- Very high purity & tight particle size distribution
- Low metal content
- High mechanical stability
- Wide choice of phases available (normal, reversed & specialty)

SiliaPrep™
Solid Phase Extraction



- Wide choice of SPE cartridge formats, 96-well plates
- Normal, reversed, fluorinated, ion exchange , and mixed-mode phases
- Certified & Specialty phases (scavengers, reagents, etc.)

