Product Information

15222 N,O-Bis(trimethylsilyl)trifluoroacetamide

for GC derivatization, LiChropur®

Storage temperature: room temperature

N,*O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) is the preferred reagent for trimethylsilylation of alcohols, alkaloids, amines and biogenic amines, carboxylic acids, phenols, and steroids.

Features/Benefits

- Very versatile. Reacts with a range of polar organic compounds, replacing active hydrogens with a trimethylsilyl (TMS) group. TMS derivatives are thermally stable but more susceptible to hydrolysis than their parent compounds.
- Reacts rapidly and more completely than Bis(trimethylsilyl)acetamide (BSA).
- BSTFA and its by-products (trimethylsilyltrifluoroacetamide and trifluoroacetamide) are more volatile than many other silylating reagents, causing less chromatographic interference.
- Hydrogen fluoride, a by-product of silylation with BSTFA (see Mechanism), reduces detector (FID) fouling.
- Very soluble in most commonly used silylation solvents. Has good solvent properties and can function as a silylation reagent without additional solvents

Typical Procedure

This procedure is intended to be a guideline and may be adapted as necessary to meet the needs of a specific application. Always take proper safety precautions when using a silylating reagetn. BSTFA is extremely sensitive to moisture and should be handled under dry conditions. This method is not recommended for carbohydrates.
Prepare a reagent blank (all components, solvents *except sample*), following the same procedure as used for the sample.

1. Weigh 1-10 mg of sample into a 5 mL reaction vessel. If appropriate, dissolve sample in solvent. If sample is in aqueous solution, evaporate to dryness, then use neat or add solvent.
2. Add excess silylating reagent. BSTFA can be used at full strength or with a solvent.* In most applications it is advisable to use an excess of the silylating reagent – at least a 2:1 molar ratio of BSA+TMCS to active hydrogen. For moderately hindered or slowly reacting compounds, use BSTFA with 1% or 10% trimethylchlorosilane catalyst. BSTFA may be mixed with other catalysts (trifluoro-acetic acid, hydrogen chloride, potassium acetate, piperidine, O-methylhydroxylamine hydrochloride, pyridine).
3. Allow the mixture to stand until silylation is complete. To determine when derivatization is complete, analyze aliquots of the sample at selected time intervals until no further increase in product peak(s) is observed.

   Derivatization times vary widely, depending upon the specific compound(s) being derivatized. Many compounds are completely derivatized as soon as they dissolve in the reagent. Compounds with poor solubility may require warming. A few compounds will require heating at 70°C for 20-30 min. Under extreme conditions compounds may require heating for up to 16 h to drive the reaction to completion. Amino acids may require reaction in a sealed tube or vial. Heat samples cautiously, near the boiling point of the mixture, until a clear solution is obtained.

* Nonpolar organic solvents such as hexane, ether, and toluene are excellent solvents for the reagent and the reaction products; they do not accelerate the rate of reaction. Polar solvents such as pyridine, DMF, dimethylsulfoxide (DMSO), tetrahydrofuran (THF), and acetonitrile are more often used because they can facilitate the reaction. Pyridine is an especially useful solvent because it can act as an HCl acceptor in silylation reactions involving organochlorosilanes.

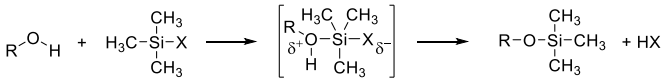
If derivatization is not complete, evaluate the addition of a catalyst, use of an appropriate solvent, higher temperature, longer time and/or higher reagent concentration. For hydroxyl groups in sterically unhindered positions in steroids combine 1-10 mg sample with 200-500 µL BSA. If material is not soluble in BSA, add 100-200 µL pyridine. Cap vessel and shake well. Warming (60°C) may accelerate dissolution. For compounds that silylate with difficulty, shake for 30 s, then heat at 70°C for 15 min.

Use a glass injection port liner or direct on-column injection when working with silylating reagents. Erratic and irreproducible results are more common when stainless steel injection ports are used.

TMS derivatives and silylating reagents react with active hydrogen atoms. Do not analyze BSTFA derivatives on stationary phases with these functional groups (*e.g.* polyethylene glycol phases). Silicones are the most useful phases for TMS derivatives combining inertness and stability with excellent separating characteristics. Nonpolar silicone phases include SPB™-1 and SPB-5. Normal hydrocarbons (carbon-hydrogen analytes with single bonds) are separated by these phases. More polar phases, SPB-1701 and SPTM-2250, separate carbon-hydrogen analytes that also contain Br, Cl, F, N, O, P, or S atoms or groups. A highly polar cyanopropylphenylsiloxane phase, SP-2330, is useful for separating fatty acid methyl esters or aromatics.

Mechanism[1-2]

Silylation is the most widely used derivatization procedure for GC analysis. In silylation, an active hydrogen is replaced by an alkylsilyl group. Compared to their parent compounds, silyl derivatives generally are more volatile, less polar, and more thermally stable.
Silyl derivatives are formed by the displacement of the active proton in –OH, –COOH, =NH, –NH2 and –SH groups.



The general reaction for the formation of trialkylsilyl derivatives is shown above.

The reaction is viewed as a nucleophilic attack upon the Si atom of the silyl donor,producing a bimolecular transition state. The leaving group X (for BSTFA, X = CF_3-CO=N-Si(CH_3)$_3$) must possess low basicity, the ability to stabilize a negative charge in the transition state, and little or no tendency for π (p-d) back bonding between itself and the silicon atom.
The ideal silyl leaving group X must be such that it is readily lost from the transition state during reaction, but possesses sufficient chemical stability in combination with the alkyl silyl group to allow long term storage of the derivatizing agent for use as required. As the formation of the transition state is reversible, the derivati-zation will only proceed to completion if the basicity of the leaving group X exceeds that of the group it replaces. The ease of derivatization of various functional groups for a given silyating agent follows this order: alcohol > phenol > carboxylic acid > amine > amide. Within this sequence reactivity towards a particular silylating reagent will also be influenced by steric hindrance, hence the ease of reactivity for alcohols follows the order: prim. > sec. > tert., and for amines: prim. > sec.

Storage/Stability

Recommended storage conditions for the unopened product are stated on the label. Store in an amber bottle or ampule at room temperature in a dry, well ventilated area. Use only in a well ventilated area. Keep away from ignition sources. Properly stored, this reagent is stable indefinitely. Moisture will decompose both TMS reagents and derivatives. To exclude moisture, this reagent is packaged under inert gas. If you store an opened container or transfer the contents to another container for later reuse, add desiccant. Before reuse, validate that your storage conditions adequately protected the reagent.

References

1. K. Blau and J. Halket, *Handbook of Derivatives for Chromatography* (2nd ed.), John Wiley & Sons, New York, 1993.
2. D.R. Knapp, *Handbook of Analytical Derivati-zation Reactions,* John Wiley & Sons, New York, 1979.

Precautions and Disclaimer

This product is for R&D use only, not for drug, household, or other uses. Please consult the Safety Data Sheet for information regarding hazards and safe handling practices.