# HMDS
## Product Specification

**HMDS (hexamethyldisilazane)**, a weak trimethysilyl donor, was the first reagent used to prepare TMS derivatives. It is most often used in silylating mixtures. HMDS has the desirable property of reacting more selectively, in some instances, than other reagents. It is a popular choice for silylating acids, alcohols, amines, and phenols. HMDS can be used alone, but derivatization usually will proceed faster with a catalyst.

HMDS also is useful for conditioning chromatography columns and for deactivating glassware or silica.

### Features/Benefits

HMDS is inexpensive and has a relatively low boiling point (124-127°C). It can be used without solvent, but its silylating power can be increased by various (mostly acidic) catalysts. The only reaction byproduct, ammonia, can leave the reaction mixture as the reaction goes to completion.

TMS derivatives are thermally stable but more susceptible to hydrolysis than their parent compounds.

### 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 reagent – consult MSDS for specific handling information. HMDS is extremely sensitive to moisture and should be handled under dry conditions.

Prepare a reagent blank (all components, solvents, etc., *except sample*), following the same procedure as used for the sample.

1. Weigh 1-10mg of sample into a 5mL reaction vessel. If appropriate, dissolve sample in solvent (see below). If sample is in aqueous solution, evaporate to dryness, then use neat or add solvent.
2. Add excess silylating reagent. HMDS 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 HMDS to active hydrogen. Not all samples are derivatized by HMDS alone. For moderately hindered or slowly reacting compounds, use HMDS with 1% or 10% TMCS catalyst.** HMDS may be mixed with other catalysts (trifluoroacetic acid, hydrogen chloride, ammonium sulfate).
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 minutes. Under extreme conditions compounds may require heating for up to 16 hours to drive the reaction to completion.

   If derivatization is not complete, the addition of a catalyst, use of an appropriate solvent, higher temperature, longer time and/or higher reagent concentration should be evaluated.

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.

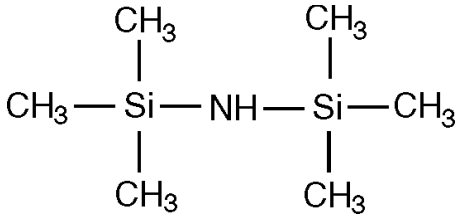
TMS derivatives and silylating reagents react with and are sensitive to active hydrogen atoms. Do not analyze HMDS derivatives on stationary phases with these functional groups (e.g., polyethylene glycol phases). Silicones are the most useful phases for TMS derivatives – they combine inertness and stability with excellent separating characteristics for these derivatives. 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 SP™-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.

* Nonpolar organic solvents such as hexane, ether, benzene, 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, dimethylformamide (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.

** The combination of HMDS and TMCS can produce a precipitate, ammonium chloride. This salt usually does not affect chromatography of the derivative, but Tallent, et al., (3) found that ammonium chloride can cause extraneous peaks with products containing epoxide rings. Some analysts separate the salt by allowing it to settle, or by centrifuging the material and removing the supernate. Tallent, et al., (3) dissolve the silyl compound in hexane and wash it with water. Formation of ammonium chloride can be avoided by using trifluoroacetic acid as the catalyst for HMDS, or using BSA as the silylating reagent.

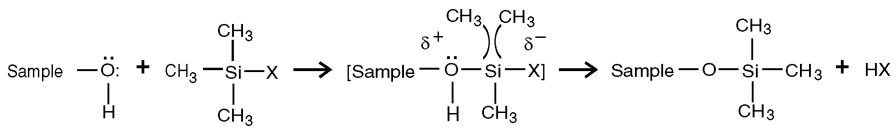
### Properties

**Structure:**



**CAS Number:**
999-97-3
**Molecular Formula:**
$(CH_3)_3SiNHSi(CH_3)_3$
**Formula Weight:** 161.40
**bp:** 125°C
**Flash Point:** 48°F (8°C)
**d:** 0.765
**$n_D$:** 1.4079 at 20°C
**Appearance:**
clear, colorless liquid with characteristic odor
moisture sensitive

796-0268




Adapted from Knapp (2).

796-0130

## 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, most often trimethylsilyl (TMS). 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, $–NH_2$, 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 silicon atom of the silyl donor, producing a bimolecular transition state. The silyl compound leaving group (X) must posses 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 compound 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 derivatization 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: primary > secondary > tertiary, and for amines: primary > secondary.

## Toxicity – Hazards – Storage – Stability

HMDS is a flammable, moisture-sensitive liquid. It may irritate eyes, skin, and/or the respiratory system. Store in a brown bottle or amber ampul at room temperature, in a dry, well ventilated area away from ignition sources. Use only in a well ventilated area and keep away from ignition sources.

Properly stored, this reagent is stable indefinitely. Recommended storage conditions for the unopened product are stated on the label. Moisture will decompose both TMS reagents and derivatives. To exclude moisture, Supelco packages this product under nitrogen. 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 Derivatization Reactions* John Wiley & Sons, New York, 1979.
3. W.H. Tallent and R. Kleiman, J. Lipid Res., 9: 146 (1968).

### Additional Reading

L.W. Woo and S.D. Lee *Capillary Gas Chromatographic Determination of Proteins and Biological Amino Acids* J. Chromatogr., Biomed. Appl., 665 (1): 15-25 (1995).


## Ordering Information

| Description | Cat. No. |
|---|---|
| **HMDS** | |
| 30mL | **33350-U** |
| 100mL | **33011** |

For information about HMDS+TMCS reagent, request Product Specification 496025; for information about HMDS+TMCS+pyridine, request 496026.

| | |
|---|---|
| **Microreaction Vessels with Hole Caps and Septa** | |
| 1mL, pk. of 12 | **33293** |
| 3mL, pk. of 12 | **33297** |
| 5mL, pk. of 12 | **33299** |
| **Books** | |
| *Handbook of Derivatives for Chromatography* | |
| K. Blau and J. Halket | **Z246220** |
| *Handbook of Analytical Derivatization Reactions* | |
| D.R. Knapp | **23561** |

Contact our Technical Service Department (phone 800-359-3041 or 814-359-3041, FAX 800-359-3044 or 814-359-5468) for expert answers to your questions.



AWN