

Basic technical explanation

WETTING, BUBBLES, ADHESION, SURFACE TREATMENT

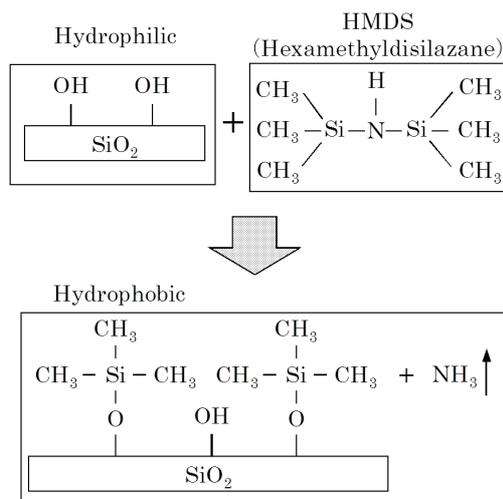
Hydrophobicity by silane coupling treatment

Controlling the wettability of solid surfaces can be broadly divided into hydrophobic and hydrophilic treatments. Silane coupling treatment and fluorine plasma treatment are typical hydrophobic treatments, while oxygen plasma treatment. Surface characteristics of materials can generally be expressed through surface energy dispersion and polar component analysis. Furthermore, the expansion coefficient is effective for analyzing wettability in liquids. This section discusses silane coupling treatment, which is closely related to coatability. Silane coupling treatment reduces the polar component of the substrate surface. That is, it replaces hydrophilic groups, such as OH groups, present on the substrate surface with hydrophobic (lipophilic) groups. Silane coupling treatment is particularly effective in improving the stability of coating films in liquids. Furthermore, since silane coupling treatment does not require a vacuum system, the equipment is relatively simple, making it. Surface stability is also high after silane coupling treatment, making it a practical process for particle dispersion, fine pattern adhesion, and penetration control in wet processes. Here, we will mainly explain hexamethyldisilazane (HMDS, $C_6H_{19}NSi_2$), a silane coupling agent that has a proven track record in semiconductor LSI processes and in the production of liquid crystal panels and solar cell panels.

Chemical properties of hexamethyldisilazane (HMDS)

HMDS(Hexamethyldisilazane):

外観:	無色透明
分子量	161.4
比重	0.774 (25°C)
沸点	126°C
蒸気圧	1733Pa
爆発範囲	0.8~16.3vol%
溶解性	水に難溶、アセトン・MEKに可溶
反応性	通常保管で安定
安全性 皮膚	軽度の刺激。
吸入	頭痛・吐き気



Silane coupling reaction of HMDS on silicon dioxide film

HMDS is a colorless, transparent, harmless liquid with a slightly pungent odor, but is relatively easy. However, it is highly reactive with moisture and requires careful storage. Its chemical properties are shown in the table above. Its boiling point, which is important for the process, is 126° C. The silane coupling reaction of HMDS, as shown in the diagram above, replaces the hydrophilic OH groups on the surface of silicon oxide films with hydrophobic 3CH₃ - SiO groups. To promote the coupling reaction, HMDS is typically supplied to the substrate in vapor or gas form. Spraying HMDS in liquid form on a polymer film can cause a gelation reaction, potentially damaging the substrate. Furthermore, as shown in the diagram above, ammonia is generated during the silane coupling reaction. Ammonia is not only harmful to humans but can also cause equipment corrosion, so thorough exhaust gas treatment is required. Furthermore, because it is strongly affected by moisture, humidity control during the treatment process is important. These factors have a significant impact on the treatment equipment configuration. Thus, the contact angle method, which indicates the wettability of a liquid, is effective for evaluating the hydrophobicity and hydrophilicity of a solid surface. Also, the surface energy γ (mJ/m²) is suitable for quantitatively evaluating surface treatment.



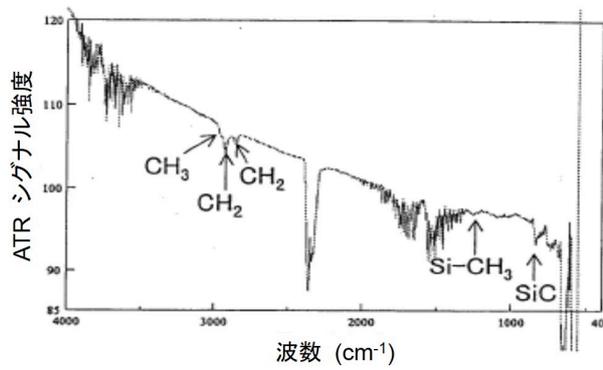
(a)未処理基板 (11度)



(b) HMDS処理(85度)

Change in wettability due to silane coupling treatment

The figure above shows the change in contact angle due to silane coupling treatment. The contact angle of pure water is low on hydrophilic surfaces such as silicon dioxide, but it increases due to the hydrophobic nature of silane coupling treatment. Chemical analysis techniques such as FT-IR and ESCA are effective for investigating the chemical bonding state of surfaces that have undergone silane coupling treatment. The figure below shows the results of an FT-IR-ATR analysis of a silicon dioxide surface. A peak is observed due to the hydrophobic groups resulting from the silane coupling treatment. Silane-coupling- treated samples should be stored in a sealed container or a reduced-pressure chamber in dry nitrogen or dry air. Under these storage conditions, the surface properties can be maintained for about half a day. However, caution is required as the surface will gradually deteriorate to a hydrophilic state after .



Hydrophobic groups after HMDS treatment analyzed by FT-IR-ATR method

References

- Akira Kawai, Junko Kawakami, "Wetting analysis of hydrophobic substrate treated by HMDS primer", J. Photopolymer Science and Technology, 20, 815-816 (2007).

Contact us here

Please feel free to contact us with any technical inquiries or requests for technical support .

[Contact form](#) >

coating >

Wetting, bubbles,
adhesion, surface
treatment >

Lithography >

Analysis, evaluation,
and analysis >