# Effect of Amino Ligands of Aminosilane Precursors in Low-Temperature Silicon Nitride Plasma-Enhanced Atomic Layer Deposition (PEALD) for Moisture Barrier Films

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## Abstract

In this work, the effect of amino ligands in aminosilane precursors on low-temperature plasma-enhanced atomic layer deposition (PEALD) of silicon nitride ($SiN_x$) for moisture barrier films was investigated. Silicon precursors including (tert-butylamino)dimethylsilane (TBADMS), bis(tert-butyl)aminosilane (BTBAS), and tris(dimethylaminosilane) (TDMAS) were compared in the PEALD process. TBADMS contains one tert-butylamine ligand, BTBAS contains two, and TDMAS contains three dimethylamine ligands. Quadrupole mass spectrometry (QMS) was used to analyze reactive species during the precursor dosing step. For TBADMS and BTBAS, the detected species included H, $CH_x$, $SiH_x$, tBu, and NHtBu, whereas for TDMAS, H, $CH_x$, and $[(CH_3)_xN]ySi$ were identified. The radicals CN, NH, $N_2$, and H were identified for all three precursors using optical emission spectroscopy (OES) during the $NH_3$ plasma process. TBADMS has fewer amino ligands than BTBAS and TDMAS, enabling efficient silicon delivery through rapid dissociation. This feature minimizes precursor adsorption issues caused by the larger molecular sizes of BTBAS and TDMAS, resulting in differences in growth per cycle (GPC) [1,2]. TBADMS exhibits the highest GPC (0.7 Å/cycle), a high N/Si ratio (1.23), the lowest water vapor transmission rate (WVTR) of $5.695 \times 10^{-3}$ g/m$^2$day. These results indicate that a lower number of amino ligands reduces steric hindrance, enhances the N/Si ratio, and lowers WVTR in $SiN_x$ films. This work supports the development of high-quality thin-film silicon nitride for moisture barrier applications in flexible OLED encapsulation.

## Reference

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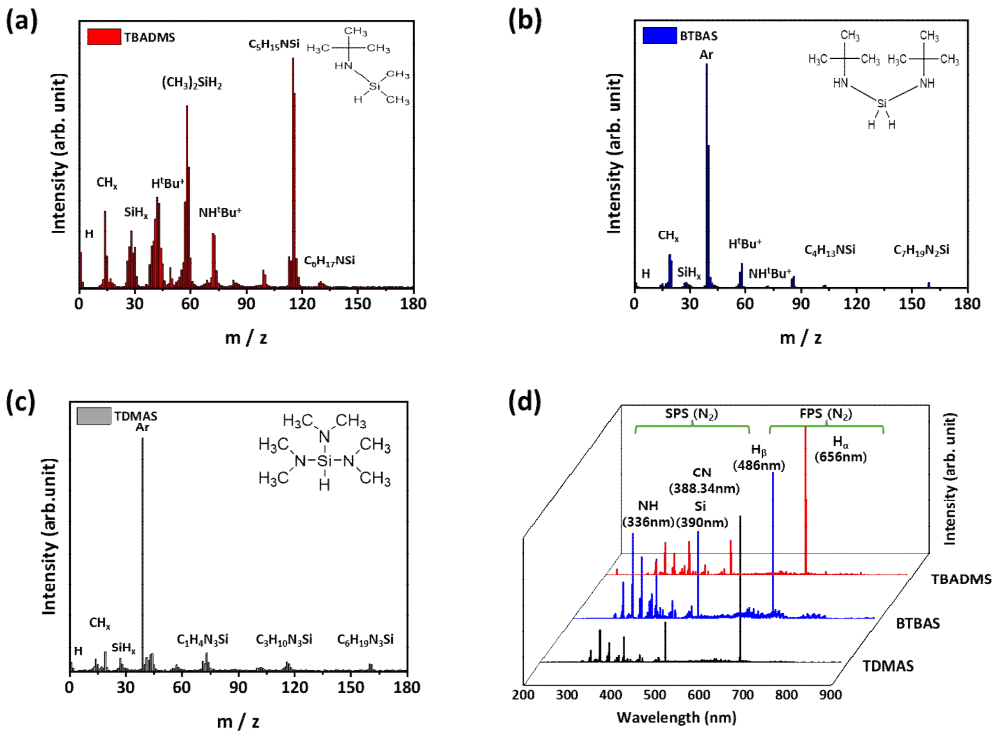


Fig. 1. QMS spectra during precursor dose step of aminosilane precursors, (a) TBADMS, (b) BTBAS, (c) TDMAS, and (d) OES spectra during $NH_3$ plasma exposure step

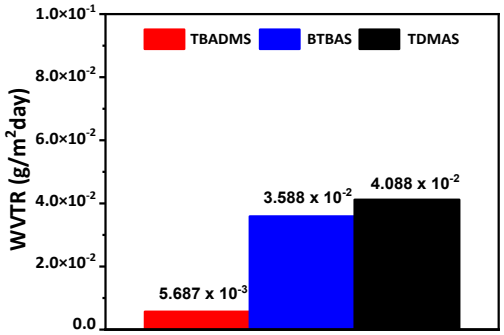


Fig. 2. Water vapor transmission rate (WVTR) of 20nm silicon nitride ($SiN_x$) at 25℃/50%

Table 1. Deposition characteristics of $SiN_x$ using different aminosilane precursors at source power 600W, 80°C

| Precursor | GPC (Å/cycle) | ALD Window (°C) | N/Si Ratio | Carbon Contents (%) | Surface Roughness (nm) | WVTR ($g/m^2day$) |
|---|---|---|---|---|---|---|
| TBADMS | 0.7 | 80~300 | 1.23 | 2.05 | 0.196 | $5.687 \times 10^{-3}$ |
| BTBAS | 0.6 | 80~300 | 1 | 2.45 | 0.184 | $3.588 \times 10^{-2}$ |
| TDMAS | 0.65 | 80~250 | 1.04 | 3.16 | 0.188 | $4.088 \times 10^{-2}$ |