# IMPROVED PERFORMANCE WITH LOW TEMPERATURE SILICON NITRIDE SPACER PROCESS

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Low-temperature BTBAS-based nitride spacers showed device performance improvement over DCS-based nitride spacers. The process and device results are discussed in this paper.

Lowering the thermal budget of processes used in the FEOL to produce more abrupt junctions is one method of engineering improved transistor performance. The source/drain spacer process is one process where lowering of the thermal budget is possible since various novel low temperature materials are available.

Recently there have been several reports of novel precursors where lower temperature deposition of silicon oxides and nitrides are possible.[1,2] One precursor is bis(tertiary-butylamino)silane (BTBAS), which can be used for depositing LPCVD silicon nitride and silicon oxide films for source/drain spacer applications.

This paper will compare BTBAS-based oxide and nitride film characteristics to those of typical LPCVD TEOS oxide and DCS-based nitride films. Both BTBAS films produced good within wafer uniformity and across load uniformity (Figure 1). Particle performance for all four films will be compared. While the both oxide films exhibited comparable room temperature film stresses, BTBAS-based nitride films showed higher flat film stress values than DCS-based nitride film. Good step coverage was exhibited by each of the oxide and nitride films. Wet etch rate studies revealed that BTBAS oxide etches slightly higher rate than TEOS oxide while nitride etches slower rate than DCS-based nitride. These films show good step coverage and showed higher dry etch rates compared to TEOS oxide and DCS-based nitride films. A typical BTBAS nitride spacer profile is shown in Figure 2.

BTBAS oxide liner and nitride spacers were compared to TEOS liners and DCS-based nitride spacers for 90 and 130nm technology device performance differences. PMOS drive currents was found to be about 10% higher than DCS-based silicon nitride spacer materials at a given off-state leakage (Figure 3). BTBAS-based NMOS devices exhibited a 5% drive current improvement. The insensitivity of device performance to the use of BTBAS oxide or TEOS oxide as the spacer material suggests the performance enhancement may be attributed mainly to the lower temperature deposition of the BTBAS nitride films and its characteristics.

References
1 R.K. Laxman, A.K. Hochberg, D.A. Roberts, F.D.W. Kaminsky and H.G. Hockenhull, “Low Temperature LPCVD Silicon Nitride Using a Chlorine-Free organosilicon Precursor”, VMIC Proceedings P.568, 1998.
2 R.K. Laxman, T.D. Anderson, and J.A. Mestemacher “A Low-Temperature Solution for Silicon Nitride Deposition”, Solid State Technology, April 2000.

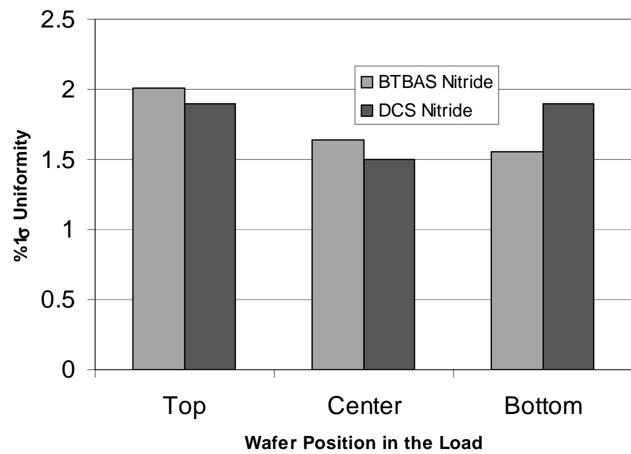


**Figure 1**. Comparison of within wafer and across load nitride film thickness uniformity.

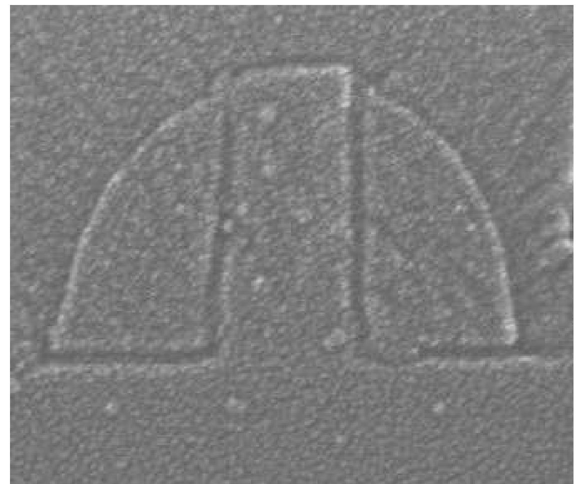

**Figure 2**. Typical cross section of a 90nm transistor spacer profile with BTBAS nitride films .

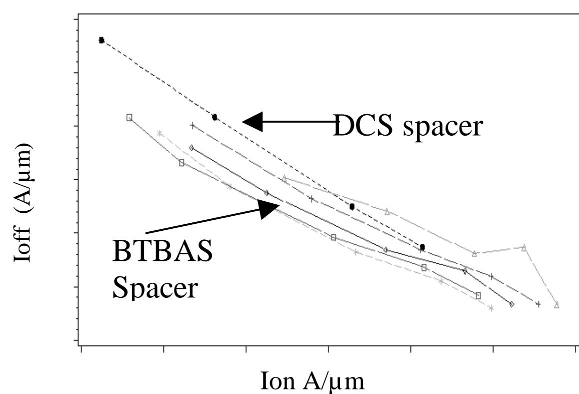


**Figure 3**. Comparison of Ion-Ioff characteristics of a 90nm technology PMOS device with BTBAS and DCS spacer films.