Characteristics of Silicon Nitride Thin Films Deposited Using a Two-step PE-ALD Process at Very High Frequencies

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Despite its many advantages such as high step-coverage, atomic-level thickness control, and uniform film deposition, atomic layer deposition (ALD) processes have encountered difficulties in applications outside of semiconductor manufacturing due to their low deposition rates. Additionally, a high temperature (>400°C) process is required for high-quality properties when the thermal ALD is used for the deposition of nitride films such as SiN_x, AlN, TiN, and TaN, leading to active development of the plasma-enhanced ALD (PE-ALD) processes and its precursor sources.

We have studied the characteristics of silicon nitride (SiN_x) films deposited using a two-step PE-ALD process shown in Fig. 1 at low temperatures (≤200°C) and very high frequencies. Fig. 2 shows the NSi-01 precursor used as the silicon source. The two-step reaction uses NH_3 and N_2 plasma as reactants. The purposes of two-step PE-ALD are high deposition rates, low damage, and reduction of impurity contents. Electron temperature (T_e), ion flux, and ion density were monitored. Thickness and refractive index were measured using ellipsometry. Impurity content was measured through XPS depth profiling. Substrate damage due to plasma was examined by TEM.

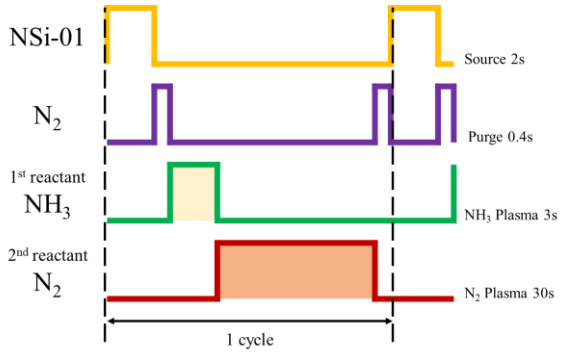

Fig. 1. The concept of the two-step PE-ALD process.

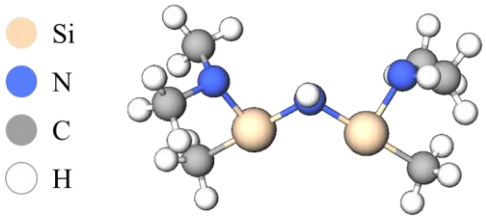

Fig. 2. Structure of NSi-01precursor.

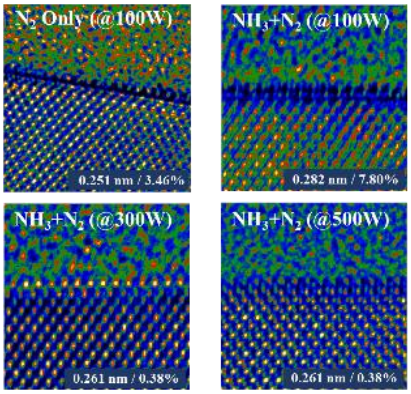

Fig. 3. TEM images of samples deposited the two-step PE-ALD at 60MHz.

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References

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