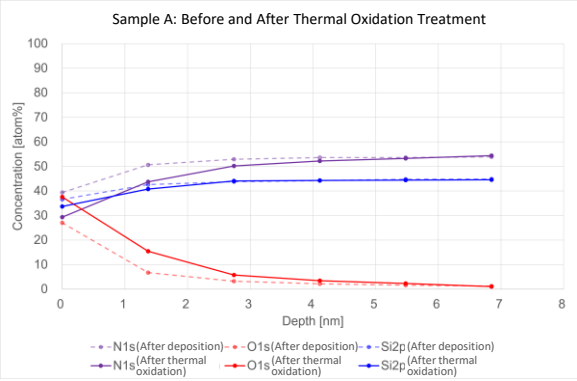
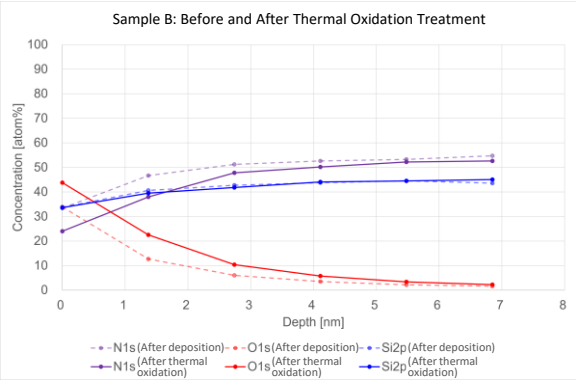
XPS Case Study #2

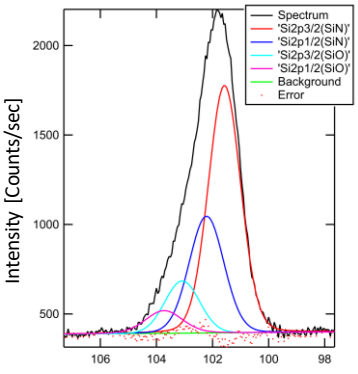
Evaluation of Thermal Oxidation in Silicon Nitride Films

XPS analysis is the most suitable analytical technique for evaluating the chemical state of the outermost surface of deposited films or substrates. Using the depth profiling XPS analysis, the states of silicon nitride films deposited on single-crystal Si substrates by two different deposition methods were evaluated before and after thermal oxidation treatment (Dry-O2, 800 ℃, 2h). Near-surface depth profiles were obtained for silicon nitride films deposited under different conditions (Samples A and B) both after deposition and after thermal oxidation treatment.

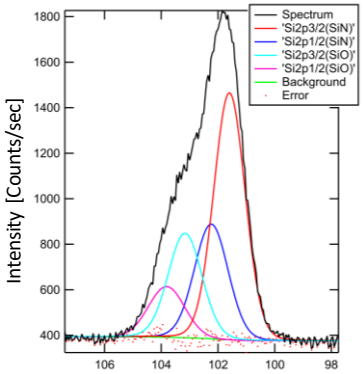




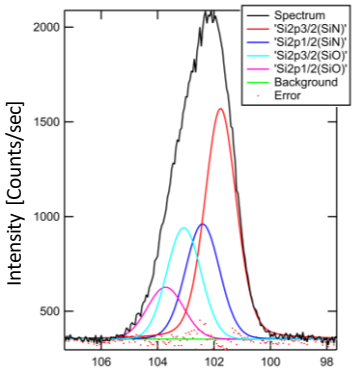
The results show that oxidation progressed in both samples after thermal oxidation treatment. A closer examination of the differences between the two samples reveals that Sample B exhibits a higher degree of film oxidation than Sample A, both after deposition and after thermal oxidation treatment. In addition, Sample A shows no significant changes at depths greater than 5 nm before and after thermal oxidation treatment, indicating that the film was essentially unaffected by the thermal oxidation process. In contrast, nitrogen desorption was observed in Sample B after thermal oxidation treatment, and a decrease in nitrogen concentration was observed even at depths greater than 5 nm. These results indicate that Sample A exhibits superior resistance to thermal oxidation compared with Sample B.



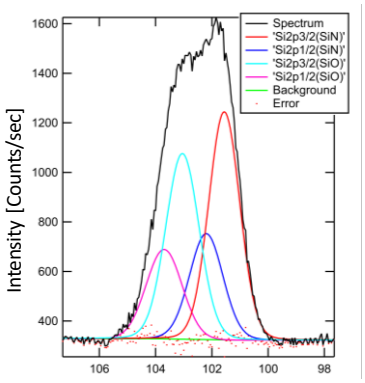
A (After deposition)



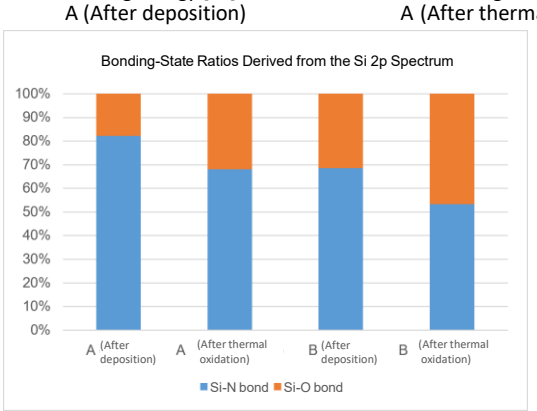
A (After thermal oxidation)



B (After deposition)



B (After thermal oxidation)



Comparison of Oxidized Bonding-State Ratios Between the Two Samples

In the case of silicon nitride films, the influence of Ar monomer ion sputtering used for depth profiling has minimal effect on the measurement results. However, depending on the film or substrate being evaluated, the surface may be affected by the sputtering process. In such cases, high-resolution spectra can be obtained from the outermost surface, enabling analysis of the bonding states and comparison between samples. Samples A and B, which were analyzed by depth profiling as described above, were also evaluated based on the bonding-state ratios obtained from the outermost surface. By comparing these bonding-state ratios, the effects of surface oxidation can be assessed, allowing the silicon nitride films to be evaluated.

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