Semiconductor Surface changes after NF_3/H_2O Plasma Cleaning Processing

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As the size of the microelectronic device becomes smaller, aspect ratio of the nano-scale patterns has been increased rapidly. In keeping with this trend, surface cleaning processing also requires a technique that can achieve higher aspect ratio of the small features in the device. When the wet cleaning process using chemical was applied to higher aspect ratio patterned samples, some problems such as pattern leaning by surface tension have to be overcome. Dry cleaning process technique has been proposed as an alternative to avoid these drawbacks. However, dry cleaning process technique has many issues including surface damage due to use of plasma processing.

We have studied the dry cleaning process using NF_3 / H_2O with remote plasma in terms of surface damage. To identify the damages to the samples during the cleaning process, we used a substrate of $Si_{1-x}Ge_x$ with various Ge concentrations. We conducted the experiments under different plasma processing conditions like H2O flow rates, power, and pressure. Changes of the surface properties were examined using atomic force microscopy (AFM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS). In addition, we fabricated antenna patterned samples to characterize the plasma induced damage (PID) during the dry cleaning process electrically. We compared the electrical properties obtained from the antenna patterned samples with the wet cleaning and plasma reactive ion etch (RIE) processed control samples.