

Preface

Recent ultra-large-scale integration (ULSI) production processes have involved the fabrication of sub-22 nm patterns on Si wafers. High-density plasma sources, such as inductively coupled plasma (ICP) and electron-cyclotron resonance (ECR) plasma, are key technologies that enable the development of precise etching processes. However, these technologies cause several types of radiation damage during etching due to charge build-up of positive ions and electrons or radiation from ultraviolet (UV), vacuum ultraviolet (VUV), and X-ray photons. Voltage generated by the charge build-up distorts ion trajectories and leads to the breakage of thin gate oxide films, the stoppage of etching, and etching-rate pattern dependence. Additionally, high-density crystal defects are generated by UV and/or VUV photons radiating from the plasma to the etching surface. These serious problems degrade the electrical characteristics of devices and increase critical dimension losses in the etching process, so they must be overcome to achieve high-quality fabrication of future nanoscale devices. In short, sub-10 nm devices require defect-free and charge-free atomic layer etching processes.

However, the interaction of UV photons and charge build-up on the surface of a given material is not clearly understood because of the difficulty in quantitatively monitoring these problems during plasma processing. In the hopes of making a breakthrough in the prevention of these problems, an on-wafer technique for monitoring the amount of charge build-up and the spectrum of UV photons has been proposed. This technique has been combined with a simulation to establish a relationship between the damage recorded by the on-wafer monitoring technique and the actual damage experienced.

In this book, a good understanding of plasma etching profile is provided with a combination of on-wafer monitoring and etching simulation.

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