

Preface

Dry etching is a key technology comparable in importance to lithography as a means for scaling and enhancing the integration level of semiconductor devices. The number of engineers engaged in dry etching development is also comparable to those working on lithography. Lithography technology is relatively easy to understand because resolution is determined by the optical wavelength and the numerical aperture (NA) of a lens. On the other hand, dry etching technology is difficult to understand because of the complicated phenomena taking place inside the etch chamber. Dry etching also requires comprehensive knowledge in electricity, physics, and chemistry because plasma-based etching is driven by physical–chemical reactions. Engineers engaged in dry etching tend to rely on their experience and intuition with their work. Too often, engineers are thrown in to do their work without first gaining an adequate understanding and knowledge of, for example, how to achieve an anisotropic etching, why Cl_2 and HBr are used for silicon etching, why fluorocarbon gases are used for SiO_2 etching, and why high density plasma, such as inductively coupled plasma (ICP), is used for poly-Si and Al etching, while a narrow-gap parallel-plate etcher with medium density plasma is used for SiO_2 etching. Sometimes, even an expert in dry etching may not understand these issues well enough.

Dry etching technology may sometimes be eclipsed by lithography, but, as already mentioned, it is a key technology that is just as critical as lithography. By way of example, in dry etching, (1) specific equipment and process technologies are used for each material, such as Si, SiO_2 , and metal; (2) new technologies are constantly being developed, such as Cu damascene processing and other new material processing; (3) plasma damages caused by charged particles lead directly to device yield losses, and it is necessary to understand their mechanism and solutions; and (4) dry etching is even more critical than lithography with double patterning technology that is a hot topic of the day because it determines dimensional accuracy and uniformity. Engineers who are engaged in such a process technology, which continues to become more diverse and evermore sophisticated in order to support an increased range of materials, should gain an adequate understanding of dry etching technology.

This book follows a unique approach that differs from existing publications, helping readers understand the basics of dry etching and its applications. Many books on dry etching focus on complicated plasma theories, or only offer long lists of data related to dry etching. This book will avoid mathematical equations as much as possible, and has been written to make dry etching mechanisms easy to understand. It is also structured to allow readers to systematically learn about the process itself and then about the equipment and the new technologies. There is a chapter dedicated to plasma damages that presents a holistic picture on the topic.

The book is designed not only to help readers understand the fundamentals of dry etching but also gain a more practical knowledge. The author hopes to provide a guiding principle for engineers who pursue dry etching development.

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