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Advanced cyclic etching to reduce the diameter of SiO2 contact holes

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With increasing integration density of dynamic random access memory (DRAM), the fabrication of contact holes with a small diameter and high aspect ratio is of primary importance. Many efforts have been made to improve the resolution limited by conventional optical lithography, including double patterning technology, extreme ultraviolet lithography, directed self-assembly lithography, and so on. Although these techniques have better resolution than that in conventional optical lithography, they face many challenges with processing difficulties, performance, throughput, and cost. In addition, widening of the contact holes during contact-hole etching is problematic to achieve small diameters of the contact holes.
In this study, an advanced cyclic etching (ACE) technique was demonstrate to reduce the diameter of contact holes having a high anisotropy and aspect ratio. The ACE technique consisted of the pre-deposition of a protection layer on the mask in a C_4F_6 /CH_2F_2/Ar plasma and a subsequent cyclic process of alternating etching and deposition steps in C_4F_6/CH_2F_2/Ar/O_2 and C_4F_6/CH_2F_2/Ar plasmas, respectively. The cyclic etch and deposition steps were repeated to obtain holes that are as deep as desired. The ACE process was compared with the conventional continuous contact-hole etching process in terms of the opening diameter and the degree of bowing of the contact holes.

Keywords
Contact hole
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Degree of bowing