

ISOTROPIC ATOMIC LAYER ETCH FOR SILICON AND GERMANIUM OXIDES

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ABSTRACT OF THE DISCLOSURE

Methods for controlled isotropic etching of layers of silicon oxide and germanium oxide with atomic scale fidelity are provided. The methods make use of a reaction of anhydrous HF with an activated surface of an oxide, with an emphasis on
10 removal of water generated in the reaction. In certain embodiments the oxide surface is first modified by adsorbing an OH-containing species (e.g., an alcohol) or by forming OH bonds using a hydrogen-containing plasma. The activated oxide is then etched by a separately introduced anhydrous HF, while the water generated in the reaction is removed from the surface of the substrate as the reaction proceeds, or at
15 any time during or after the reaction. These methods may be used in interconnect pre-clean applications, gate dielectric processing, manufacturing of memory devices, or any other applications where accurate removal of one or multiple atomic layers of material is desired.

20 Figure 1