Cyclic etching of copper thin films using two sequential steps

Eun Tack Lim, Jae Sang Choi, Jin Su Ryu, Moon Hwan Cha, and Chee Won Chung
Department of Chemical Engineering, Inha University
100 Inharo, Michuhol-Ku, Incheon 22212, Korea
E-mail : cwchung@inha.ac.kr

Copper has been used as the interconnects in the semiconductor memory devices because it has many advantages such as low resistance and low diffusivity. In addition, the electromigration phenomenon which causes wire deformation and breakage occurs less on copper [1]. Currently, copper has been etched through a damascene process because direct dry etching process has not been developed. However, the damascene process reveals some limitations in achieving fine patterns of several nanometers [2]. To solve this issue regarding the damascene process, the intense studies on copper patterning are being performed using conventional dry etching.
Cyclic etching, as another approach to etch the copper films, can be a prospective etching technique. Cyclic etching including surface modification and its removal can provide the good etching performance of copper films by effectively inducing surface reaction and precisely controlling the etch depth. These results are attributed to the nature of self-limiting process and the removal of the film by layer-by-layer.
There are possible various gas combinations in cyclic etching of copper films. In this study, cyclic etching with two sequential steps of surface modification and ion bombardment was performed. The surface modification and etch depth (etch rate) of copper film were confirmed using surface profilometer, scanning probe microscopy, and field emission scanning electron microscopy (FESEM) as a function of various parameters such as the time of surface modification (plasma exposure) and the bombardment energy of ions. Besides, the resultant etch profile and etch mechanism of copper film in the cyclic etching have been investigated by FESEM, X-ray photoelectron spectroscopy, and Raman spectroscopy.

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