Dry etching of copper thin films in high density plasma of organic acids

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To increase the performance and the operating speed of semiconductors, the degree of integration must be increased. Copper is a next-generation wiring material that should be patterned with fine geometry in order to increase the degree of integration. In the conventional semiconductor wiring process, aluminum has been widely used because of its low cost and good electrical properties. However, copper has been substituted for the wiring material to obtain faster signal transmission speed of semiconductor devices and to remove the disadvantages of using current aluminum metal lines.

Copper has a resistivity that is 35% lower than that of aluminum, which results in 15% faster signal and low leakage, resulting in low power consumption. Copper has a low probability of disconnection and plays a roll of a more stable wiring since the electron migration resistance, which is a characteristic of stability and durability of the device, is higher than that of aluminum. When copper is used as a wiring material, signal transmissionis improved because of increase integration degree due to decrease in wiring width, improvement in device performance through reduction of signal delay, and decrease the signal distortion of mutual interference with neighboring other wiring. Therefore, copper etching is recognized as an essential technology on the roadmap of semiconductor technology.

In order to form a under micro-scale pattern, a damascene process is currently used since it is difficult to use dry etching of copper under micro-scale patterns. In the damascene process, an adhesion layer between the copper and the dielectric material causes the increase in the resistance of the copper wiring. Therefore, it is required to develop a conventional dry etching of Cu thin film instead of a damascene process for the fabrication of next generation semiconductor devices using very fine line widths.

To etch copper thin film using conventional dry etching, it is important to select an etch gas that is chemically reactive with copper. There are various compounds that are formed through chemical reaction. Among them, we have chosen a mechanism that is either volatile or gaseous, which is easily removed by the sputtering and does not produce redeposition on the pattern side walls. In this study, the copper thin film was etched by using the organic acids in inductively coupled plasma reactive ion etching. We analyzed the effect of the etching process parameters and investigated the etching mechanism of the copper thin films.

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