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Etching characteristics of ZnO thin films using inductively coupled BCl_3/Ar and Cl_2/Ar plasma

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Plasma etching of ZnO thin films with a positive photoresist pattern was investigated by varying BCl_3/Ar and Cl_2/Ar gas mixing ratio, top electrode power, and bottom electrode power. In order to understand the etching mechanism, optical emission spectroscopy (OES) and X-ray photoelectron spectroscopy (XPS) are used to investigate the species in the plasma and the chemical binding states of the ZnO surface etched with various $Cl_2/(Cl_2+Ar)$ mixing ratios, respectively. With the percentage of Cl_2 gas flow in Cl_2/Ar chemistry increased, the etch rate of ZnO was gradually increased at the Cl_2 flow ratio at up to 80 % of Cl_2 gas flow ratio and then decreased. And the etch rate of ZnO was increased with increasing the bottom electrode power and decreasing the top electrode power. The combined results of etch rate, OES and XPS measurements showed that the etch rates of ZnO layers are mostly influenced by an effective removal of $ZnCl_x$ by the energetic ion-bombardment and the addition of Cl_2 gas plays an important role in determining the etch characteristics of ZnO that is facilitated by surface chlorination of Zn atoms by the increased Cl radicals.