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Etching characteristics of Al-Nd alloy thin films using magnetized inductively coupled plasma

Y. J. Lee, H. R. Han, and G. Y. Yeom

Department of Materials Engineering, Sungkyunkwan University, Suwon, 440-746, Korea

For advanced TFT-LCD manufacturing processes, dry etching of thin-film layers(a-Si, SiN_x, S/D & gate electrodes, ITO etc.) is increasingly preferred instead of conventional wet etching processes. To dry etch Al gate electrode which is advantageous for reducing propagation delay time of scan signals, high etch rate, slope angle control, and etch uniformity are required. For the Al gate electrode, some metals such as Ti and Nd are added in Al to prevent hillocks during post-annealing processes in addition to gaining low-resistivity(<10uΩ·cm), high performance to heat tolerance and corrosion tolerance of Al thin films. In the case of Al-Nd alloy films, however, low etch rate and poor selectivity over photoresist are remained as a problem.

In this study, to enhance the etch rates together with etch uniformity of Al-Nd alloys, magnetized inductively coupled plasma(MICP) have been used instead of conventional ICP and the effects of various magnets and processes conditions have been studied. MICP was consisted of fourteen pairs of permanent magnets arranged along the inside of chamber wall and also a Helmholtz type axial electromagnets was located outside the chamber. Gas combinations of Cl_2, BCl_3, and HBr were used with pressures between 5mTorr and 30mTorr, rf-bias voltages from –50V to –200V, and inductive powers from 400W to 800W. In the case of Cl_2/BCl_3 plasma chemistry, the etch rate of Al-Nd films and etch selectivity over photoresist increased with BCl_3 rich etch chemistries for both with and without the magnets. The highest etch rate of 1,000 Å/min, however, could be obtained with the magnets(both the multi-dipole magnets and the electromagnets). Under an optimized electromagnetic strength, etch uniformity of less than 5% also could be obtained under the above conditions.