Microstructure and properties of aluminum oxynitride films prepared by r.f. reactive sputtering

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Aluminum oxynitride (AlO_xN_y) films have been studied for the application in optical coatings, microelectronics, and protective coatings. The AlO_xN_y films are very attractive due to variability of the physical properties with the concentration of aluminum, oxygen and nitrogen. From the view point of protective coatings, it is desirable to control the crystal structure of the films at the same time. However, it was reported that only an amorphous characteristic was obtained for AlO_xN_y monolithic films deposited by d.c.-reactive sputtering [1] and r.f.-reactive sputtering [2].

In the present study, AlO_xN_y films have been prepared by r.f.-reactive sputtering in a facing target-type sputtering (FTS) system with a mixture of argon and nitrogen atmosphere using Al_2O_3 target of 99.5% in purity. The films were deposited at 1 kW on silicon wafer and fused siclica substrate, and the film thickness was controlled to ~2μm by adjusting the sputtering time. The crystalline structure of thin films was studied by XRD and TEM. Mechanical and optical properties of the films were measured by a submicron indentation system (H-100XYp, Fischer) and spectrophotometer (U-4000, Hitachi) , respectively.

When the substrate temperature was not higher than ~150 °C, all AlO_xN_y films showed amorphous-like XRD patterns. At the substrate temperature of ~200 °C, a halo pattern of XRD spectrum disappeared and a few broad diffraction peaks appeared. Peak positions of Electron diffraction pattern (Fig.1) for this film did not completely correspond to any phase, but agreed with a few parts of ι-Al_2O_3(JCPDS 12-0539), some part of AlON (48-1580, 48-1582) and AlN (25-1133) peak positions. This result implys that AlO_xN_y films deposited at ~200 °C or higher consist of a mixed structure of these phases. The dark-field TEM images of the film revealed that grain size of the film was about 6 nm in diameter. This AlO_xN_y film exhibited higher hardness of ~28 GPa and higher transparency of visible light than those of Al-O films.

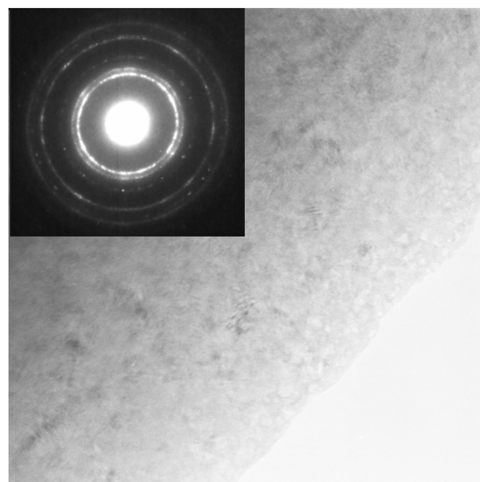

Fig.1 Plane-view TEM micrograph and corresponding diffraction pattern of AlO_xN_y films deposited at 200 °C.

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