BCl_3 계열 유도결합 플라즈마를 이용한 사파이어 기판의 식각 특성

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Plasma Etching Characteristics of Sapphire Substrate using BCl_3-based Inductively Coupled Plasma

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Abstract : The development of dry etching process for sapphire wafer with plasma has been key issues for the opto-electric devices. The challenges are increasing control and obtaining low plasma induced-damage because an unwanted scattering of radiation is caused by the spatial disorder of pattern and variation of surface roughness. The plasma-induced damages during plasma etching process can be classified as impurity contamination of residual etch products or bonding disruption in lattice due to charged particle bombardment. Therefor, fine pattern technology with low damaged etching process and high etch rate are urgently needed. Until now, there are a lot of reports on the etching of sapphire wafer with using Cl_2/Ar, BCl_3/Ar, HBr/Ar and so on [1]. However, the etch behavior of sapphire wafer have investigated with variation of only one parameter while other parameters are fixed.

In this study, we investigated the effect of pressure and other parameters on the etch rate and the selectivity. We selected BCl_3 as an etchant because BCl_3 plasmas are widely used in etching process of oxide materials. In plasma, the BCl_3 molecule can be dissociated into B radical, B^+ ion, Cl radical and Cl^+ ion. However, the BCl_3 molecule can be dissociated into B radical or B^+ ion easier than Cl radical or Cl^+ ion.

First, we evaluated the etch behaviors of sapphire wafer in BCl_3/additive gases (Ar, N_2,Cl_2) gases. The behavior of etch rate of sapphire substrate was monitored as a function of additive gas ratio to BCl_3 based plasma, total flow rate, r.f. power, d.c. bias under different pressures of 5 mTorr, 10 mTorr, 20 mTorr and 30 mTorr. The etch rates of sapphire wafer, SiO_2 and PR were measured with using alpha step surface profiler. In order to understand the changes of radicals, volume density of Cl, B radical and BCl molecule were investigated with optical emission spectroscopy (OES). The chemical states of Al_2O_3 thin films were studied with energy dispersive X-ray (EDX) and depth profile anlysis of auger electron spectroscopy (AES). The enhancement of sapphire substrate can be explained by the reactive ion etching mechanism with the competition of the formation of volatile $AlCl_3$, Al_2Cl_6 or $BOCl_3$ and the sputter effect by energetic ions.

Key Words : Saphire substrate, BCl_3, Plasma, Etch, OES

참고 문헌

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