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ECRCVD a-C:F 층간절연막 및 Cu/Ta/a-C:F/Si 다층구조의 특성에 미치는 플라즈마 처리의 영향

(Effect of Plasma Treatment on Properties of Interlayer Dielectric Fluoricated Amorphous Carbon (a-C:F) Prepared by ECRCVD and Cu/Ta/a-C:F/Si Multilayer Structure)

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1. INTRODUCTION

With decreasing device design rules, fabrication methods for thin film multilevel interconnections(MLIs) have become an area of intense research interest in the study of ULSI circuits. In multilevel interconnections, it has been predicted that semiconductor device performance is limited by RC delay. Therefore, copper and low-k-based interconnect technology has become an area of intense research interest in ULSI applications. Fluorinated amorphous carbon is considered one of the most promising materials as low dielectric interlayer materials. It has low dielectric constant and thermal stability. In this study, in order to decrease fluorine concentration at the film surface and suppress the reaction at the interface between the Ta and the a-C:F film, plasma was applied to the as-deposited a-C:F films.

2. EXPERIMENTAL

The a-C:F films were deposited by an ECRCVD system using gas mixture of C_2F_6 and CH_4. The post-plasma treatment of the a-C:F films was carried out using H_2, N_2 plasma in situ at 200℃ with a microwave power of 150~170W. Ta film was deposited using DC magnetron sputtering followed by Cu deposition in order to avoid oxidation of the Ta layer. The elemental distribution and the chemical composition of the a-C:F films were investigated using X-ray photoelectron spectroscopy(XPS). Crystallographic orientations of Ta and Cu films were measured using an X-ray diffractometer (XRD). The degree of defluorination and the interface reactions taking place in the Cu/Ta/a-C:F/Si system were evaluated by secondary ion mass spectrometry (SIMS).

3. RESULT

The post-plasma treatment produces more reactive surfaces and affects the fluorne concentration of the a-C:F film surface and the structure of chemical bonding without a noticeably change in the inner film structure. The dielectric constant and the refractive index of the plasma treated films increased slightly. A strong interaction between Ta and a-C:F at the interface and the defluorination of a-C:F film occurred during Ta sputter deposition. The post plasma treatment of a-C:F films suppressed the outdiffusiton of fluorine atoms from a-C:F films during the Ta deposition. Therefore, the post plasma treatment was regarded to be a very effective method for suppressing defluorination and improving thermal stability of Ta/a-C:F/Si structure.