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Study on the interface of Cu on PI system by X-ray photoelectron spectroscopy.

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Polyimide(PI) has a low dielectric constant along with a low dissipation factor, high thermal resistance, high chemical resistance. Hence it is a very good candidate for an interlevel dielectric(ILD) and the passivation coating in high density interconnection systems. Cu is a promising materials in the multilevel metallization and interconnection for low resistivity and relatively low electromigration properties and high melting point. But some problems are there in the use of PI\Cu system in the metallization, such as poor adhedion and diffusion of Cu into PI. Ionized cluster beam deposition (ICBD) is very useful film fabrication technique that enables flexible control of film properties such as molecular orientation, film crystallinity, and film-substrate interfacial property. In this technique, ionized clusters are accelerated by the attractive potential applied between crucibles and the substrate. We expected the surface cleaning effect and the interface-mixing effect to occur due to the bombardment by accelerated clusters which may result in cleaning and smoothing of the interface as well as improved the adhesion between the film and the substrate and also expected high packing density and low surface roughness. We compare the interface of PI\Cu system fabricated by ICB and other method.

In this study, we focus on the interface properties of Cu on PI system deeply related to the adhesion and diffusion properties so, we prepared PI films by ICB or spin-coating and compare the interface properties by X-ray photoelectron spectroscopy. PI films were deposited on the Si(100) substrate by ICB technique at various deposition conditions and by spin coating. Cu were deposited on these films by Ar^+ ion sputtering of Cu target We have examined the interface of Cu on PI systems by X-ray photoelectron spectroscopy(XPS). We used Phi 5700 X-ray photoelectron system with hemispherical energy analyzer and used Al-kα X-ray source.

XPS shows that PI films deposited by ICB(ICB-PI) have better film quality than PI fabricated by other methods. According to the C1s spectrum and O1s spectrum, carbonyl oxigen peak(C=O) more rapidly decrease in ICB-PI than PI film

fabricated by spin coating(spin-coated PI). From Cu2p spectrum and Cu LMM spectrum, in the initial mode, Cu peak in initial growth more clear and more rapidly increase in ICB-PI than spin coated-PI. According to the N1s spectrum, imide ring peak more rapidly decrease in ICB-PI than spin coated-PI, we expect ICB-PI have better packing density and more flat interface between Cu and PI than spin-coated PI films. Also, we have examined packing density by ellipsometry and surface roughness by atomic force microscopy(AFM) to confirm these results. We obtained the same results by ellipsometry and AFM, that is, ICB-PI films have more flat surface and larger packing density than spin coated PI films.

According to the study on the interface of Cu on PI system analyzed by XPS, we have concluded that ICB-PI films have more flat surface and larger packing density than spin-coated PI films. and moreover, PI films deposited at V_{acc}=800V, V_e=200 have the most flat surface and largest packing density.

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