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Surface Reformed Thick Spin-on-glass for Planar Interconnection

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A simple, but excellent planarization technology has been developed utilizing a newly developed Spin-on-Glass(SOG) technique. It has been applied to fabrication of 0.8μm-level two-level interconnections. The SOG material, HSG2200 (by Hitachi Chemical Co.) is a kind of polyalkyl-siloxane which shows excellent planarization and crack free characteristics up to 500℃ in N_2. A novel technique for reforming the HSG (HSG2200) film surface has also been developed to suppress crack generation in the film by the O_2 plasma-resist ashing process.

The advantages of this technology over conventional s-SOG (silanol type SOG) are as follows.

1. Stress in the HSG film is less than 1/10 that in the s-SOG(Fig. 1) film baked at the temperature below 700℃, enabling a thicker film to be realized by HSG (0.6μm) than by s-SOG (0.2μm).
2. A 3 layered interlevel dielectric using HSG, CVD-SiO/HSG/CVD-SiO (0.2/0.6/0.2 μm), provides a far better planarizing effect than by a conventional CVD-SiO/s-SOG/CVD-SiO (0.2/0.2/0.2 μm) structure (Fig. 2, 3).

However, the HSG film had the disadvantage that many cracks were in it by a resist ashing process. This is inferred to be due to rapid shrinkage of the film caused by oxidation by the O_2 plasma. Fig. 4 shows the infrared absorption intensity of the $-CH_3$ band of the 0.6 μm-thick siloxane films baked at 200℃ for 30 min., as a function of exposure time to O_2 plasma (7 Torr, 300W, 13.56MHz in a barrel type reactor;asher).

Various film surface pretreatments were investigated to improve the siloxane film resistance to the O_2 plasma. O_2 RIE (Reactive Ion Etching) pretreatment was found to be an effective method. A very thin, gas-tight SiO_2-like layer, formed by O_2 RIE pretreatment, prevented oxygen plasma from reaching the inner siloxane layer under the reformed surface. Fig. 5 shows the infrared absorption intensity of the $-CH_3$ band of the 0.6 μm-thick 200℃-baked siloxane films measured just after each of a series of treatments. It is clearly seen from this figure that reduction of $-CH_3$ band intensity during O_2 plasma treatment is drastically reduced by the O_2 RIE pretreatment as compared with the result without pretreatment shown in Fig. 4.

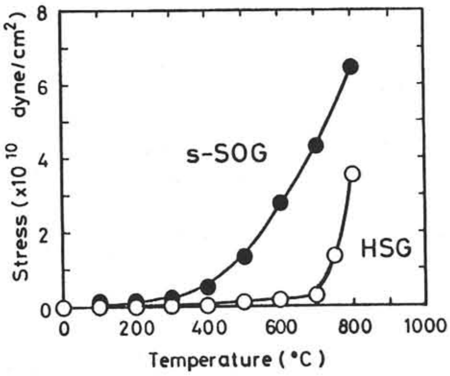

Fig. 1 Stress in SOG films measured at elevated temperature.

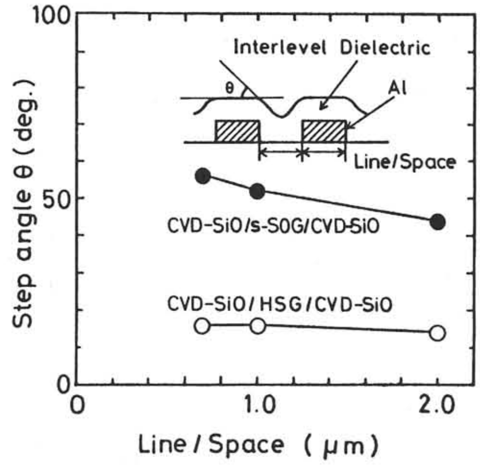

Fig. 2 Planarization capability of 3 layered-interlevel dielectrics over 0.7μm step height.

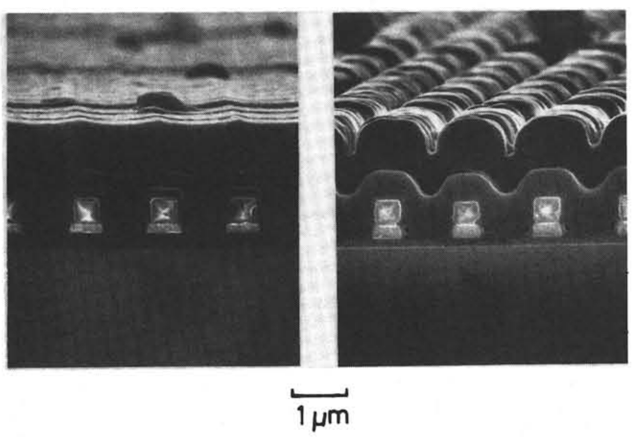

Fig. 3 Cross section of 2 level interconnection

(a) CVD-SiO/HSG/CVD-SiO (b) CVD-SiO/s-SOG/CVD-SiO

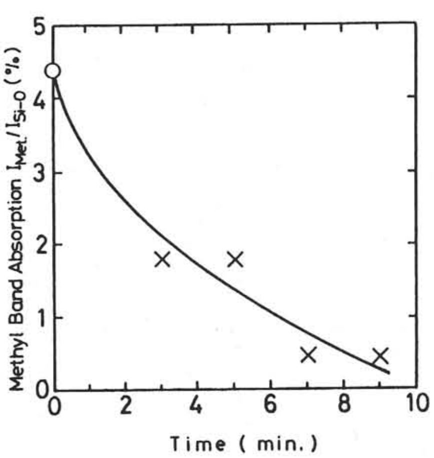

Fig. 4 Methyl band absorption of HSG film normalized by Si-O band absorption vs. time in asher O_2 plasma. x indicates generation of cracks.

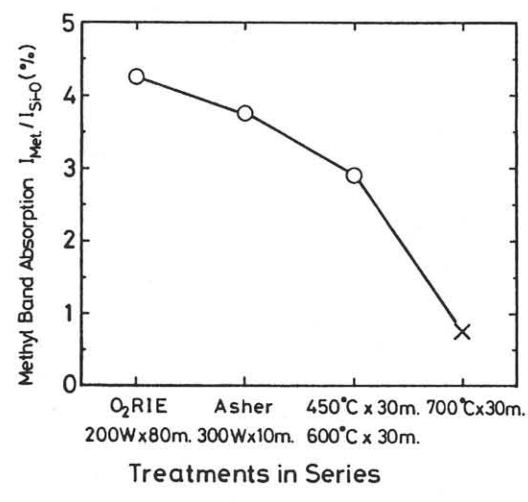

Fig. 5 Methyl band absorption of HSG film normalized by Si-O band absorption measured after a series of treatments. x indicates generation of cracks.