An Improvement of I-V Characteristics in Cu-Damascene Interconnects by Use of Supercritical Fluid Treatments

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[Introduction] Insulating films with dielectric constant value of less than 2.5 are required as interlayer materials for Cu-damascene interconnecting structures to meet demands of the 65nm node technology.

ASET is also developing some kinds of organic low-k dielectrics from the viewpoint of PFC-free process technologies.

As for the recovering of an inter-layer-dielectric properties up to an intrinsic level, ASET presented about the supercritical fluid (SCF) treatment of CO_2 including de-ionized water rinsing using MIS capacitors, which is effective even after interconnect formation. [1]

[Experiment] In this work, SCF effects are confirmed by comb-shaped testing devices with 1 or 2 layers of Cu-damascene interconnects using the organic low-k film. A diagram of usual way to measure the current density between adjacent interconnects is shown in the figure 1. To decrease the initial current density around 10^{-7}A/cm^2 at 1MV/cm, a part of samples are washed by the CO_2-SCF treatment.

[Results] Distributions of current density are compared between samples with and without an SCF treatment. As shown in the figure 2, there is a small but obvious difference which means the effectiveness of SCF treatment on devices that resembles actual interconnects in ULSI.

To investigate the effect on lifetime, samples of typical characteristics are tested by a TDDB method at room temperature. The result shown in the figure 3 indicates the longer lifetime of treated samples than the lifetime of non-treatment.

[Conclusion] The reasons of these improvements are not so clear at present, but de-ionized water molecules that are apt to connect to CO_2 molecules may remove charges. [1]

Considering that in general the organic film is now eagerly developed for the application to ULSI recently [2], the SCF treatment may become useful as a new treatment process for ULSI by an optimization because of the improvement in I-V characteristics.

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[References]

[1] T. Fukuda et al. : Proc. 2002 IITC, p217-219, 2002
[2] T. Kokubo et al. :Proc. 2002 IITC, p51-53, 2002

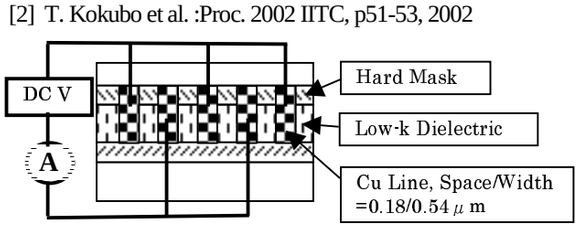

Figure 1. Comb-shaped testing devices for the in-plane current measurements.

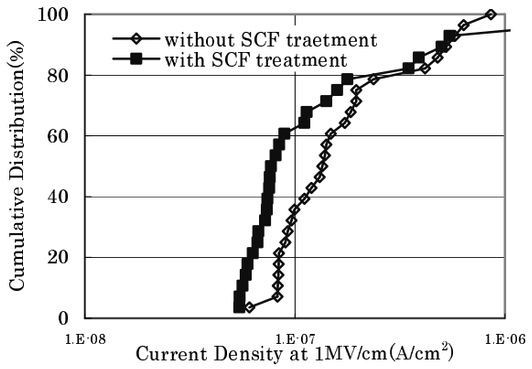

Figure 2. Cumulative distribution of current densities for samples with and without the CO_2 SCF treatment (8MPa, 60degree C, 15min).

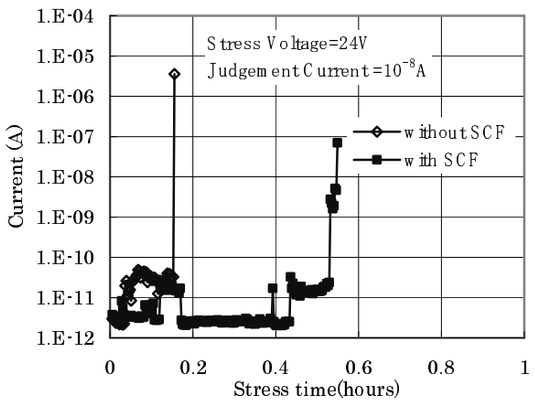

Figure 3. Comparison of typical TDDB results.