PLASMA AND UV ASSISTED RAPIDCURING OF LOW-K MATERIALS

C. Waldfried, A. Margolis, O. Escorcia, Q. Han, R. Albano, I. Berry

Axcelis Technologies, Inc.
7600 Standish Place, Rockville, MD 20855, USA

ABSTRACT

Improvements in the performance of integrated circuit (IC) devices require a reduction in the RC time delay, which is achieved by using interconnect materials with low resistance (i.e. copper interconnects) and interlayer dielectric (ILD) materials with low dielectric constant (low-k materials). Many low-k materials require a curing process after deposition to ensure proper film attributes. Traditionally the curing implies a furnace heat treatment at temperatures of up to 450°C for as long as 90 minutes. Axcelis has developed a novel cure technology[1] (RapidCure) which employs plasma and/or UV to achieve equivalent or improved cure results in typically less than 2 minutes. The RapidCure process addresses the stringent BEOL integration requirements of low-k and ultra-low-k materials, targeting important properties to ensure high yields such as electrical integrity, thermal integrity and mechanical strength, while substantially improving thermal budget. As design rules go to 100nm and beyond, the need for dielectrics with dielectric constants of $k < 2.2$ require the introduction of porous low-k materials. Porous low-k films are intrinsically weaker than dense films and often exhibit poor mechanical properties, therefore making them generally unable to withstand the rigors of later processing steps. The RapidCure process, which has resulted in ultra low-k porous films with improved mechanical strength, may be the enabling technology for porous low-k materials. The values of the Young's modulus and film hardness of rapidly cured films are 2 to 4 times higher than those of conventional furnace-cured films. This technology has been successfully applied to various porous low-k materials, including materials from the inorganic, organic, and inorganic-organic hybrid classes.

This paper will focus on the general method and applications of the RapidCure technology. We will present analytical results from film thickness, refractive index, FTIR, TDS, and contact angle measurements and correlate these findings to k-value, film hardness and modulus data. We will emphasize general characteristics of the RapidCure process, discussing commonalties and differences for this process between inorganic, organic and hybrid low-k materials.

[1] U.S. Patent Applications 09/952,649, 09/952,398, 09/906,276, and *09/681,332*.

[2] "Plasma Curing Of Ultra Low-k Porous Silicon Dioxide Films", Proc. of the 1st Internat. Conf. on Semicond. Techn. (ISTC 2001), vol. 2, p. 234.