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A Study on the Characteristics of Low Dielectric Constant SiOC(-H) Films Deposited with Various Substrate Temperature

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This paper is on the influence of substrate temperature of the SiOC(-H) thin films with low dielectric constant were deposited on p-type Si(100) substrates by using a transformer coupled plasma chemical vapor deposition (TCPCVD) system with a mixture of dimethoxydimethylsilane (DMDMS: $Si(OCH_3)_2(CH_3)_2$) and oxygen precursors. The films were deposited at various substrate temperature with a radio frequency (rf) power of 600 W and working pressure of 100 mTorr. Film thickness and refractive index are measured by field emission scanning electron microscopy and ellipsometer, respectively. The deposition rate decrease from 71 nm/min to 42 nm/min and refractive index is increased from 1.37 to 1.46. Fourier transform infrared (FTIR) spectroscopy and X-ray photoelectron spectroscopy (XPS) are used to study the various chemical bonding species, such as the Si-O-Si network: ring, open and cage linked Si-O-C bonds: $Si\text{-}CH_3$: $C\text{-}H_x$: and -OH related bonds, in the SiOC(-H) films. As substrate temperature increases from RT to 400℃, the intensity of $Si\text{-}CH_3$ bond reduced, demonstrating that it is easier to break weaker $Si\text{-}CH_3$ and CH_m (m=1-3) bonds at higher deposition temperature, resulting in less content of $Si\text{-}CH_3$ in the film.