NW-002

The Effect of Adsorbed Water and Silanol Groups on the Dielectric Properties of Mesoporous Silica Materials

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Mesoporous materials have been potential candidates for low dielectric constant materials and low refractive index materials because of its high porosity. For the first application, their surface is usually modified to become hydrophobic and for the second application their thermal stability and porosity are required to be high. In current communication, a series of mesoporous silica thin films (MSTF) were fabricatedby spin coating the sol solution containing tetraethyorthosilicate (TEOS) as silicon precursor, hydrogen chloride acid as catalyst, ethanol as solvent, water and cetyltrimethylammoniumbromide (CTAB) as structuring agent on to the silicon wafer. The template was removed by calcinations resulted in mesoporous phase which were confirmed by small angle X-ray diffraction. Surface properties of MSTFwere investigated by Fourier transform infrared spectroscopy (FTIR). Adsorbed water and three different silanol groups including isolated silanols, mutual silanols and chained silanols were detected and estimated. Their amounts are closely relative to the stirring time of the sol solutions. As increasing the stirring time, the chained silanols tend to change in to mutual silanol and then isolated silanols. The high porosity of MSTF was also ensured by oblique FTIR spectra. Metal insulator metal (MIM) or metal insulator semiconductor (MIS) devices were employed to investigate the electrical properties of MSTF. The results show that the adsorbed water is the main factor degrading the dielectric property of MSTF whereas at high temperature when adsorbed water is almost removed the electrical properties of MSTF are induced by hydrogen bonding systems including silanol groups and chemisorbed water molecules. Additionally, water and silanols cause the instability of MSTF.