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Hydrophobicity of Silica Thin Films: The Deconvolution and Interpretation by Fourier-Transform Infrared Spectroscopy

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Abstract

This work investigated the synthesis of dimethoxydimethylsilane:tetraethoxysilane (DMDMS:TEOS) silica thin films as well as the effect of DMDMS:TEOS molar ratios and calcination temperature on hydrophobic properties of silica thin films and its correlation with the FTIR spectra behaviour. The silica thin films were synthesized by sol-gel method using combination of DMDMS and TEOS as silica precursors, ethanol as solvent and ammonia as catalyst, with DMDMS and TEOS molar ratio of 10:90, 25:75, 50:50, 75:25 and 90:10. The results showed that DMDMS:TEOS molar ratio had significant impact on the hydrophobic properties of silica thin films coated on a glass surface. Furthermore, the correlation between water contact angle (WCA) and DMDMS:TEOS molar ratio was found to be in a parabolic shape. Concurrently, the maximum apex of the parabola obtained was observed on the DMDMS:TEOS molar ratio of 50:50 for all calcination temperature. It was clearly observed that the silica xerogel exhibiting notable change in relative peak intensities showed FTIR peak splitting of $\upsilon_{asymmetric}$ Si-O-Si. To uncover what happened at the FTIR peak, the deconvolution was conducted in Gaussian approach. It was established that the changes in the Gaussian peak component were related to DMDMS:TEOS molar ratios and the calcination temperature that allowed us to tailor the DMDMS:TEOS silica polymer structure model based on the peak intensity ratios. With the increase of DMDMS:TEOS molar ratio, the ratio of (cyclic Si-O-Si)/ (linear Si-O-Si) decreased, whilst the ratio of (C-H)/(linear Si-O-Si) increased. Both ratios intersected at DMDMS:TEOS molar ratio of 50:50 with contribution factor ratio of 1:16 and 1:50 for silica xerogel calcined at 300°C and 500°C respectively. The importance of this research is the DMDMS:TEOS molar ratio plays an important role in determining the hydrophobic properties of thin films.

Keywords: hydrophobicity; thin film; dimethoxydimethylsilane; deconvolution.