

Conclusions

Three methods have been used to study water uptake in polymer photoresist films. Infrared Near Field Scanning Optical Microscopy (IR-NSOM) helped determine the regions of the photoresist that absorbed water. Atomic Force Microscopy (AFM) was employed to further understand the water-induced differential swelling of the photoresist pattern and changes in mechanical properties of the polymers. Fourier Transform Infrared (FTIR) spectroscopy measurements were performed to characterize the interactions between the water molecules and the polymer chains in the photoresist. This helped provide an explanation of deprotection reaction kinetics.

An interesting direction for future work would be to combine the microscopy and spectroscopy aspects. Micro-FTIR has been developed by other researchers and currently has a spatial resolution limit of about 10 μm .^{1,2} Unfortunately this is not small enough to resolve the features of the photoresists studied in this work, but if the method is improved enough to do so, measurements could provide spatially resolved information on water-polymer interactions in different regions of the patterned polymer.

Work is currently being done to improve the IR-NSOM. Because a large obstacle is the fabrication of a reproducible fiber tip, an improved probe is being investigated. Apertureless NSOM uses an AFM as a base instrument with a metallized commercial Si tip. Infrared radiation illuminates the tip and scatters on to the sample with a small spot size. An optical image of the sample with spatial

resolution better than 30 nm can be obtained. The probe is more reliable and robust, so multiple experiments under a variety of conditions can be obtained, possibly leading to more quantitative information on water sorption in polymers. There is also improved resolution over the fiber-based IR-NSOM. However, it is still a challenge to interpret the optical images, and many researchers are investigating the contrast mechanisms at work.³⁻⁶

Another method under investigation which shows promise is Scanning Transmission X-ray Microscopy (STXM). This technique boasts chemical selectivity, high spatial resolution, and fast measurements. Investigations on latent images of polymer photoresists have already shown spatial resolution below 50 nm.⁷ A goal is to use the technique to monitor acid diffusion during the post-exposure bake. With a few modifications, water diffusion through the film could also be investigated. This method could contribute more quantitative information which could aid in the understanding of photoresist processing and dynamics.

References for Conclusions

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