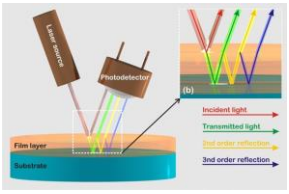
ThetaMetrisis APPLICATION NOTE #016

Real-time monitoring of spectral sensitivity of a photoresist film due to ambient light exposure



Goal: Accurate monitoring of transmittance changes of a photoresist film caused by ambient light exposure.

Introduction: In general, the spectral sensitivity of common photoresists ranges from the DUV to the short wave VIS part of the spectrum. Without suited yellow/orange filters, artificial light as well as daylight will expose substrates coated with photo resist layers within seconds thus making reproducible litho-processes impossible. In our study, the standard room light exposure on a ~3µm thick AZ5214 photoresist coated on a microscope glass is investigated.

Means & Methods: The photoresist was deposited on top of a microscope glass in a "safe lighting" condition by using an orange filter, and then was stored into a dark container. An FR-pOrtable, operating in 370-1020nm spectral range, able to support transmittance measurements was ready to start measurements on a room with ambient light. After the removal of the sample from the dark container, it was placed under the probe of FR-pOrtable which was monitoring the transmittance spectrum at real-time.

Results: The recorded measurements are summarized in a plot (Figure 1) that illustrates the transmittance data versus time in seconds. These results clearly suggest a) from the transmittance modulation in the >460nm spectral regime the AZ5214 thickness can be measured when considering the related refractive index values b) the photoresist film present high absorbance for the spectral regime <430nm which is the lithographically useful spectral regime. The AZ5214 film thickness was measured to be 2.92um, Figure 2, in very good agreement with independent stylus profilometry measurements. The decrease of absorbance vs. time in the standard laboratory conditions is in agreement with the chemistry of AZ5214 (a mixture of mainly cresol novolak and diazonaphthoquinone (DNQ)). At short exposure times the light is absorbed at a short distance from the film surface but as exposure continue the top part of the resist film bleaches, i.e. becoming UV-transparent, so while exposure continues, light is able to penetrate the whole film. As a consequence, the exposed resist film thickness goes approximately linear with the exposure dose.

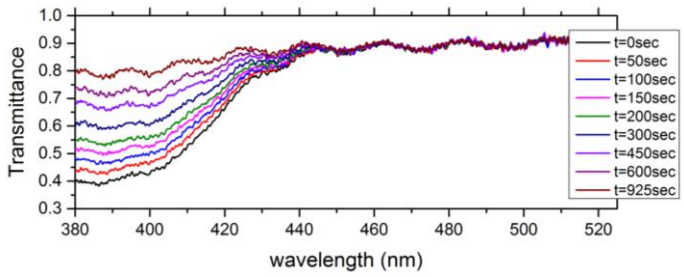


Figure 1: Transmission spectrum of the AZ5214 resist film after certain time exposures to room light

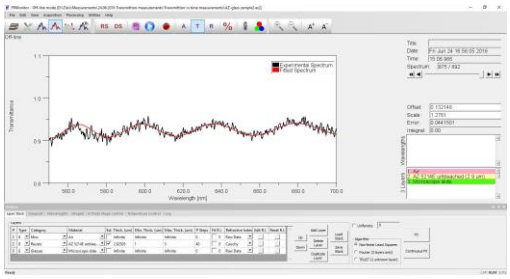


Figure 2: Thickness measurement of the AZ5214 film in the spectral regime where the absorbance is negligible

Conclusions: The accurate real-time monitoring of exposed/unexposed transition through transmittance measurements of a photoresist due to ambient light using a FR-pOrtable was successfully demonstrated. In addition by the same measurements the photoresist film thickness was also measured by applying the interference equations in the low-absorbance spectral range.

[1] M. Bolsen, "AZ 5200 Resists for Positive- and Negative Patterning," 1988.
2] MicroChemicals GmbH, "Exposure of Photoresists", 2013