

157nm nanolithographic materials : Photo Resist and ARC films

Recently, there has been increasing interest in using 157nm F₂ laser sources in projection lithography as successors to 193nm based systems. This would follow the historical trends in the microelectronic industry where wavelength reduction is used to improve feature resolution. At 248 and 193nm, spectroscopic ellipsometry is a very efficient method to characterize photoresists and antireflective coatings. A new system (PUV) has been developed, working into a purged glove box to reduce oxygen and water contamination. The optical setup includes a premonochromator in the polariser arm to avoid photobleaching. The spectral range of the instrument is 137-700nm.

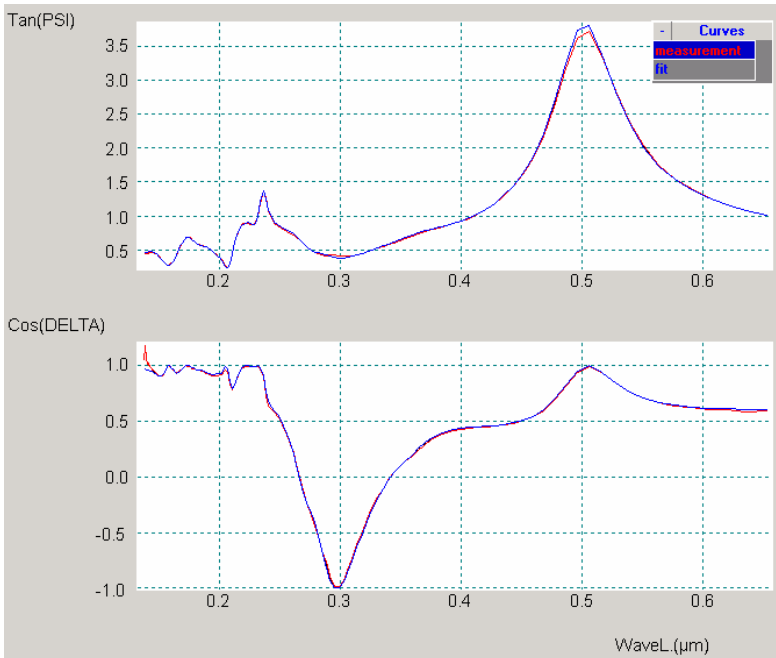


Figure 1. SE measurement and fit. PhotoResist (100nm)/Glass.

Photo Resist films

One example of measurement on a photo resist film is reported in Figure 1. SE measurements have been performed in the wavelength range 137-650nm (1.9-9eV).

From the measurement of two parameters $\tan \Psi$ and $\cos \Delta$, thickness, refractive index n and extinction coefficient k can be extracted (*). These parameters are determined accurately and independently one from another.

After running SOPRA's regression, the best fit and the experimental curves are presented. The excellent agreement between the measurement and the model is to be seen.

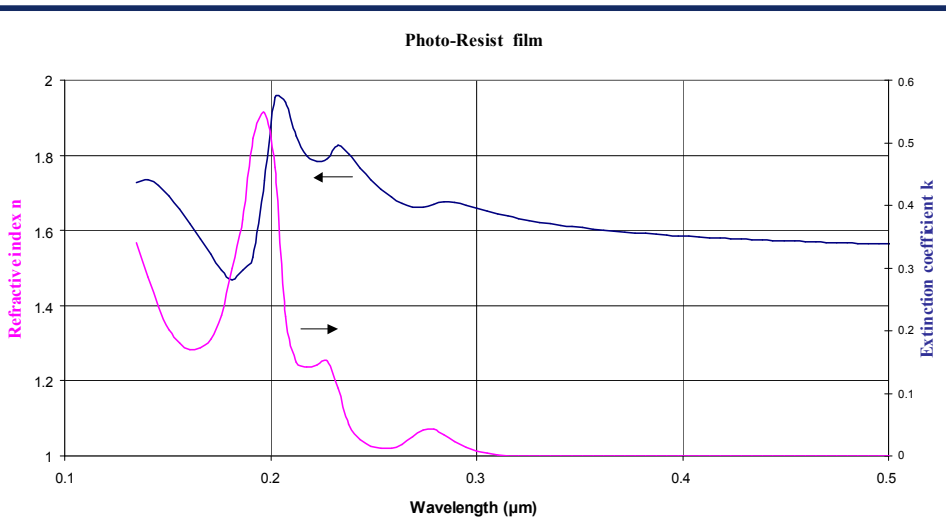


Figure 2. N & k of PhotoResist.

Figure 2 shows the refractive indices n and k determined on this 100nm PhotoResist layer.

(*) Refer to SOPRA web page (www.SOPRA-SA.com) for tutorial on ellipsometry principles, and terminology.

SiON ARC

Hereafter, we have measured six different SiON_x samples deposited on Si substrate by rf-sputtering at various rf-power, silane flow and N₂O flow. Measurements have been made in the 140-650nm spectral range. The simulation is made assuming an homogeneous SiON_x layer and adjusting the thickness and the optical indices. The optical indices are found to depend drastically on the deposition conditions as shown on Figure 3.

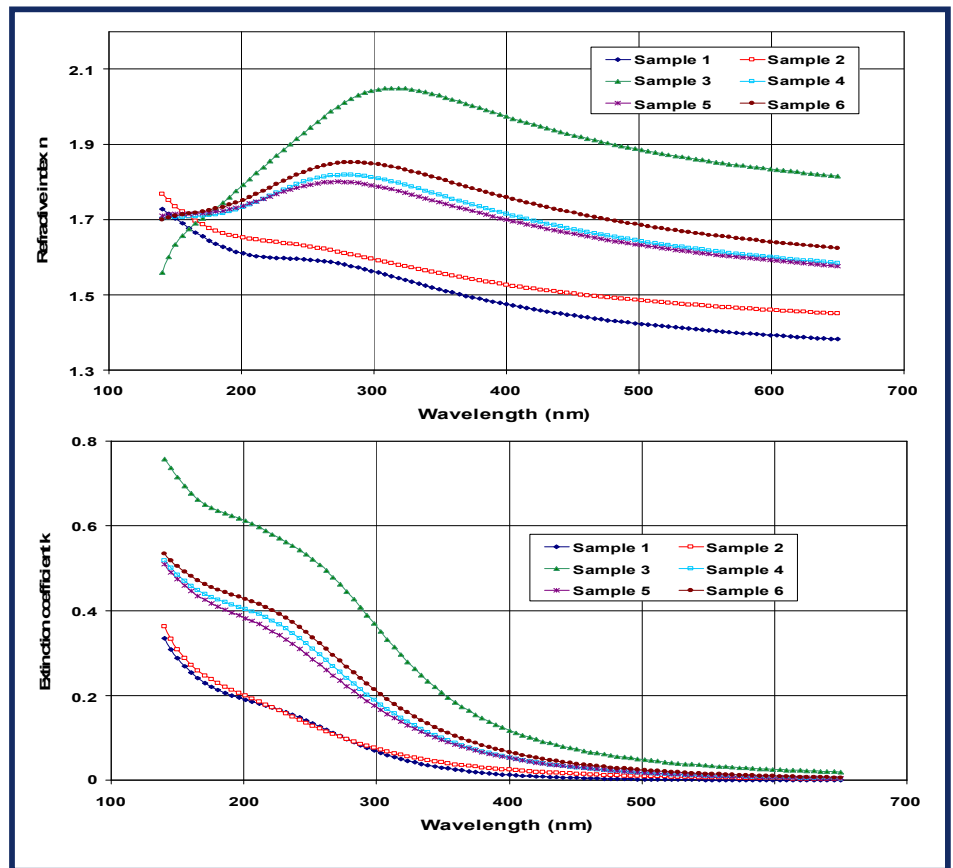


Figure 3. N & k of different SiON layers.

Compared to more simple techniques like reflectance, ellipsometry has several advantages. First, the measurement is made on a ratio of two signals (R_p/R_s where R_p and R_s are the reflection coefficients of the two polarisations parallel and perpendicular to the incidence plane). So the measurement is less dependent of the source fluctuations and the accuracy of the measurement is generally better than a photometric one. There is also no need of reference sample since the measurement is self-calibrated. Finally, two independent parameters (amplitude ratio and phase) are measured simultaneously instead of one for reflectance or transmittance, which allows direct extraction of complex indices without using Kramers-Kronig methods. Photoresist behavior versus exposure dose has for example been determined by this method. At 157nm, the layer thickness is generally smaller than for the current lithographic generation. So the correlation between thickness and indices is enhanced making more difficult the use of photometric techniques. Moreover, at shorter wavelength diffuse scattering from surfaces and contamination becomes more important so that ellipsometry is the best alternative.

Using SOPRA's Spectroscopic Ellipsometer down to 140 nm allows to determine accurately the optical properties of antireflective coatings or photoresist films which will be used for the new and future optical lithography at 157, 193 and 248 nm wavelengths.

Please contact us for any further information.