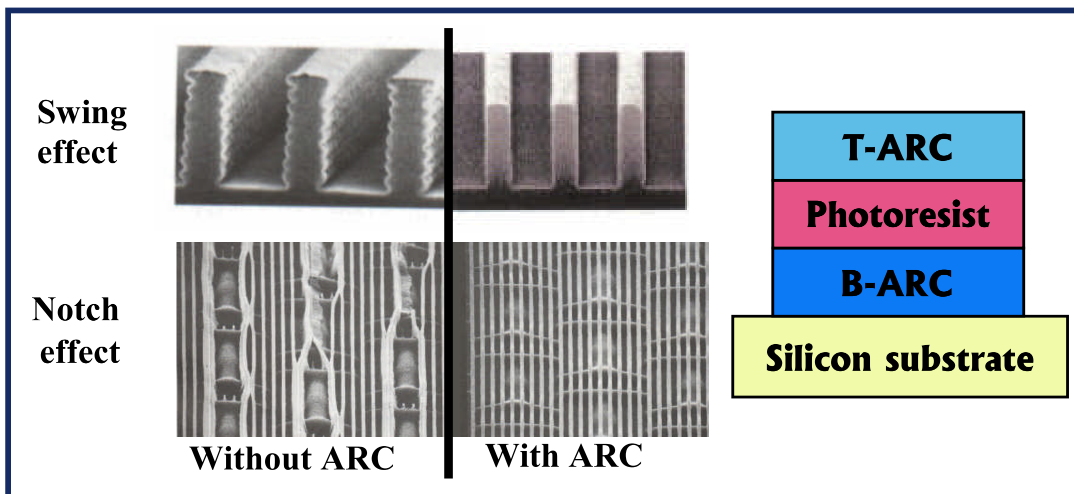
ARC LAYERS

The microelectronics industry has reduced the linewidth requirements for new design rule devices fabrication. When exposure wavelengths are shorter in order to enable the printing of smaller geometry, the effects of substrate reflectivity, interference and reflective notching phenomena, increase dramatically and leads to linewidth deformations. Therefore **some form of control will be required for DUV lithographic manufacturing.** .

Bottom AntiReflective Coatings (B-ARC) are now commonly applied to guarantee better imaging quality and wider photolithography process window. These layers **cancel the reflection from the substrate and thus avoid to destroy the pattern resolution**. The ARC allows to improve the linewidth control and to keep the Critical Dimension (CD) stable as shown Figure 1.



To reduce to the maximum thin film interference and to improve the light coupling, another ARC (T- ARC) can be added at the top of the stack. The T-ARC / photoresist / B-ARC film stack is shown in Figure 1.

Figure 1. Reduction of swing and notch effects using ARC.

The anti-reflecting conditions are directly related to the thickness and the refractive index of the layers. It does point out the importance of having a good knowledge of the optical properties and the thickness of the layer.

Spectroscopic Ellipsometry, which is rapid, contactless, non-destructive and allows on-line control, is a powerful tool to perform such a characterisation over a broad spectral range, and with high precision at every single photolithography wavelength of interest.

From the measurement of two parameters tan Ψ and cos Δ, thickness, refractive index N and extinction coefficient K can be extracted. These parameters are determined accurately and independently with each other.

The **refractive indices** of Anti-Reflective Coatings and photoresist determined with one of the **SOPRA's Ellipsometers**, are shown in Figure 2.

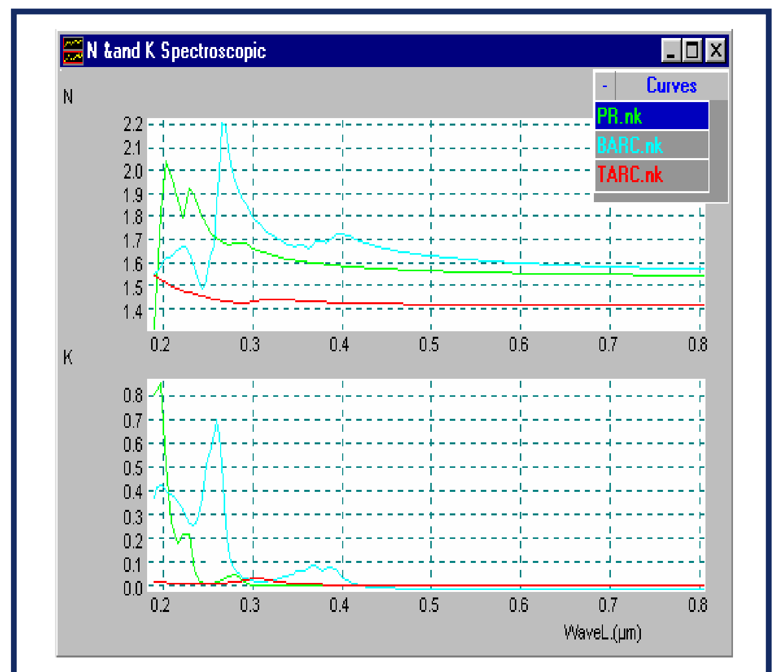


Figure 2. n&k of Top ARC, PR and Bottom ARC.

Simulations of reflectivity, using the **WINELLI software** developed by SOPRA, allow to determine the optimum thickness of ARC to achieve the maximum reduction in the swing ratio as shown in Figure 3.

This modelling capability offers a powerful tool for optimising the stack structure and predicting its imaging response based on actual measured optical coefficients.

The optimised bottom antireflective coating provides swing effect reduction and notching protection.

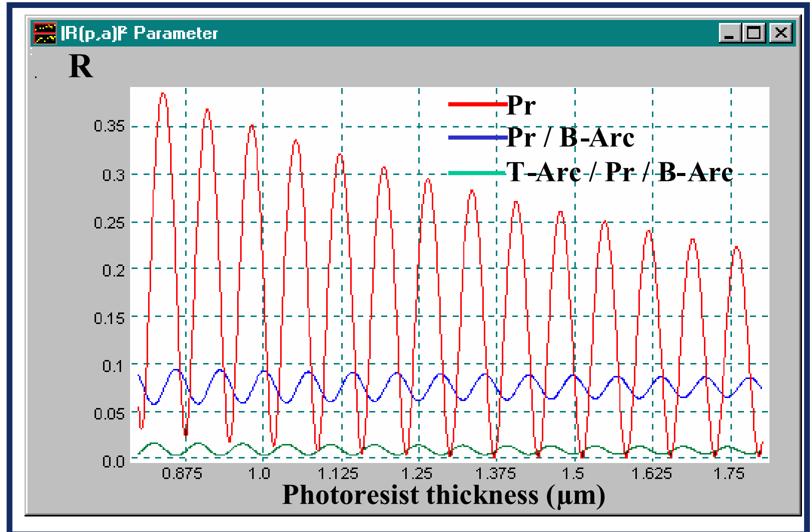
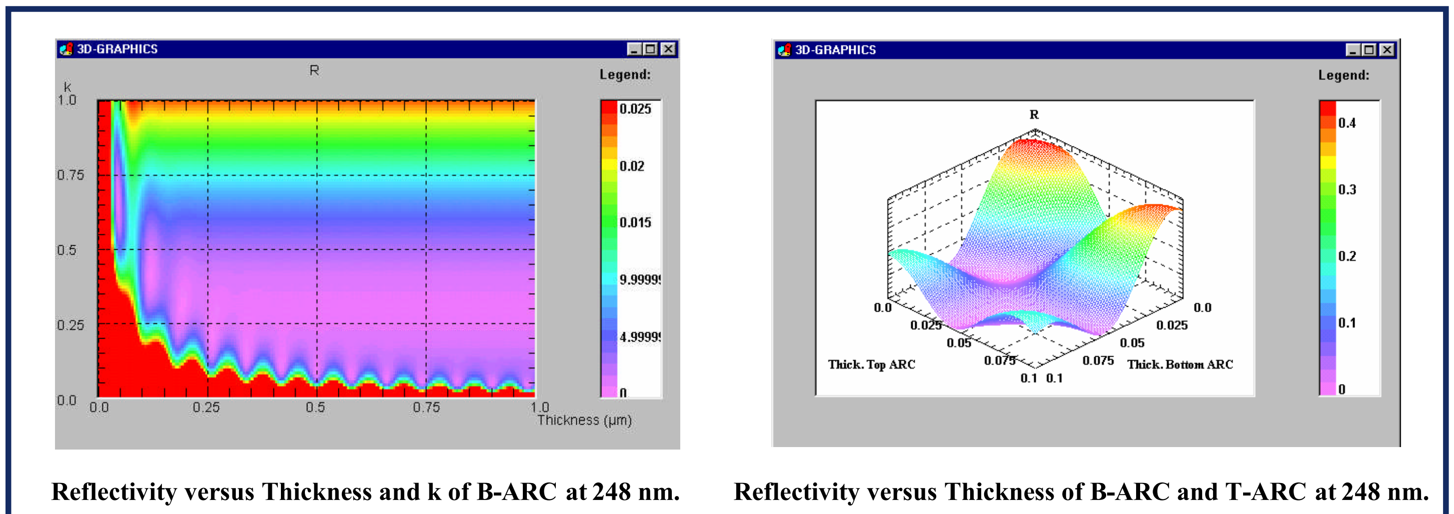


Figure 3. Reflectivity of stack versus PR thickness at 248 nm.

We can simulate with WINELLI software the optimum values of extinction coefficient and thickness of bottom antireflective coatings, which allow to destroy light reaching the resist bottom. Figure 5 shows the simulation of the reflectivity for different floating parameters at 248 nm.



Reflectivity versus Thickness and k of B-ARC at 248 nm. **Reflectivity versus Thickness of B-ARC and T-ARC at 248 nm.**

Figure 4

Using SOPRA's Spectroscopic Ellipsometer down to 190 nm in the deep UV range allows to determine accurately the optical properties of top and bottom antireflective coatings which will be used for DUV manufacturing technology.

Accurate characterisation of antireflective coatings with S.E. by SOPRA improve process control and wider photolithographic process window making the ArF excimer laser a promising candidate for 1GDRAM class lithography tool.

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