1 Oxidation

1.1 Film thickness measurement

1.1.1 Metrology

Oxide layers are transparent films. If light is irradiated onto the wafer and reflected, various properties of the light wave are changed which can be detected with metering devices. If there are multiple layers stacked on each other they must differ in optical properties to allow a determination of the materials.

To monitor the film thickness across the wafer, several measuring points are quantified (e.g. 5 points on 150 mm, 9 points on 200 mm, 13 on 300 mm wafers). Thereby not only the absolute thickness is relevant but also the uniformity across the wafer, because the uniformity is important in subsequent processes. If the deposited layer is too thick or too thin material has to be removed (e.g. by etching) or deposited again.

1.1.2 Interferometry

If light waves interfere with each other the individual waves can be amplified, weakened or annihilated. This phenomenon can be used in semiconductor industry for measuring translucent films.

If light is irradiated onto a wafer some beams of light are reflected on top of it and some penetrate into the film. The latter will be reflected on bottom of this layer or penetrate into another layer beneath and so on.

A range of different wavelengths is irradiated onto the wafer and depending on the film thickness of the radiographed layer, the light waves interefere in different ways. Thus results in characteristic interference. A photometer can analyze the reflected light and calculate the film's thickness.

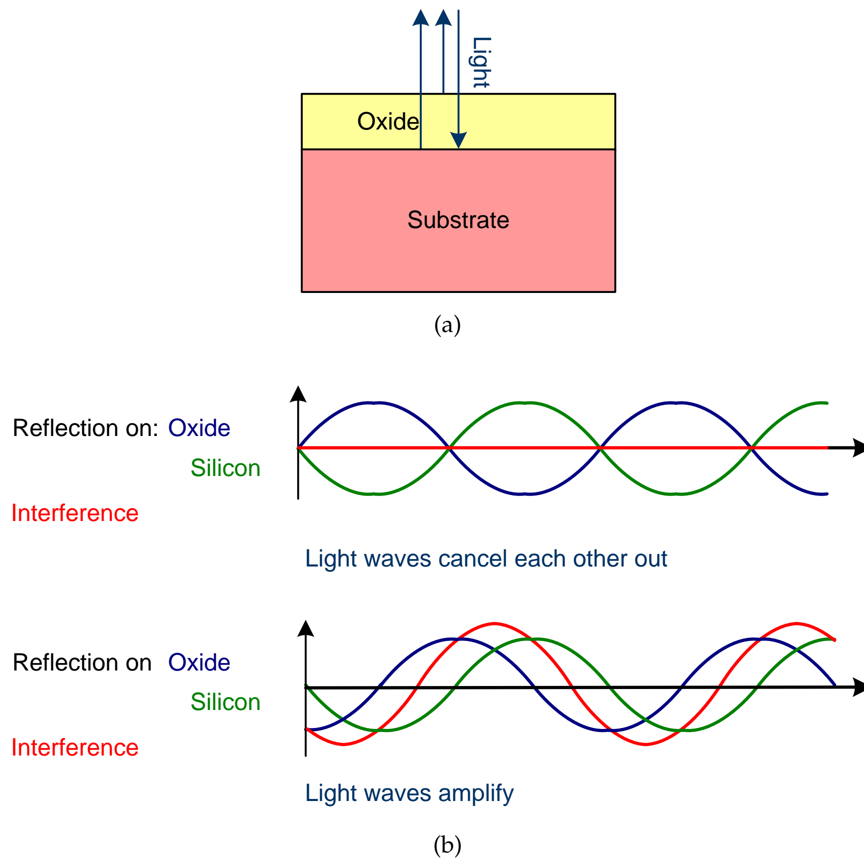

Fig. 1.1: (a) Interferometry, (b) destructive and constructive superimposition of lightwaves

Interferometry can be used on films which are thicker than one fourth of the irradiated light.

1.1.3 Ellipsometry

Ellipsometry is the determination of the optical polarization of light. In metrology for example linear polarized light is irradiated in a fixed angle onto the wafer.

During reflection of light on top of the wafer or on interfaces of two layers, the light's polarization is changed. This change can be detected with an analyzer. By use of known optical properties of the film (e.g. angle of refraction, absorbance), of the light and of the polarization as well, the film thickness can be calculated.

In contrast to the interferometry, elliptical measurements can be used for films with a

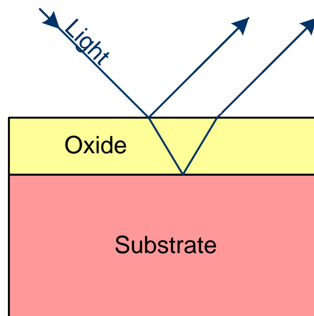

Fig. 1.2: Ellipsometry

thickness less than one fourth of the irradiated light.

1.1.4 Appraisal of the measurement

With these technics the thickness measurement can only be carried out indirect, therefor the optical parameters of the measured layers have to be known. Based on these parameters a model is constructed and a measurement is simulated. Subsequent the simulation is compared to the real measurement and the parameters of the model are varied until the measurement and the simulation do fit best.

The more parameteres are varied, the easier a fit can be achieved but the more uncertain is the result. Often a parameter, called goodness of fit (GOF), gives information about how well the simulation and the measurement do match (0 to 100 %).

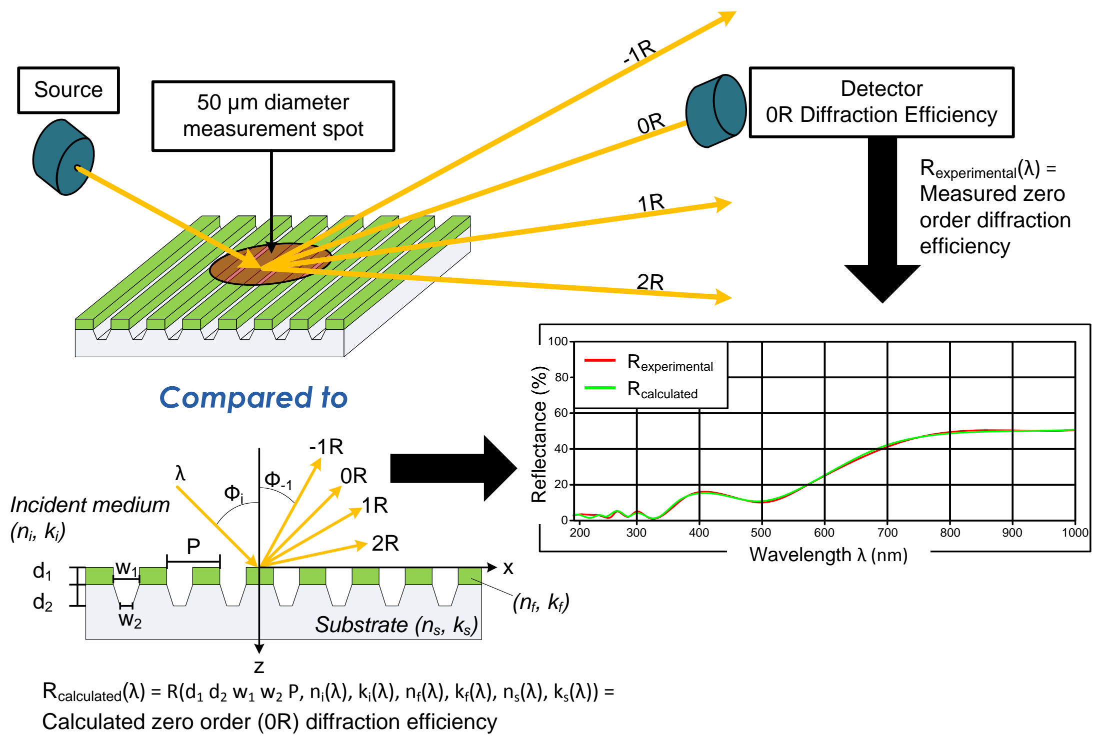

Fig. 1.3: Simulated and real measurement