Optosurf wafer roughness measurements

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2023-06-13

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1 Wafer roughness measurement

In this document a new methodology to characterize wafer roughness is presented. This methodology uses a scattered light sensor that enables optical, contactless measurement of different types of surfaces (Optosurf)

2 Optosurf 32 pixel line detector

The Optosurf head is able to detect scattered light in order to measure roughness. The roughness of a sample can be determined from the shape of the optical field that goes into the detector, for rougher samples the optical field will be wider. The optosurf is also able to determine the lateral shift of the optical field, this is equivalent to the incoming angle of the sample's reflected light.

In order to sample the optical field, the optosurf head has a 32-pixel linear detector within +-15 deg on-axis. The optical field is sampled by performing a window integration over each pixel, obtaining 32 sampling points. The measured parameter to characterize the sample roughness is called Aq and is calculated by reconstructing a histogram of the sampling points. The sampling process of the optical field and Aq value calculation is illustrated in Figure ??.

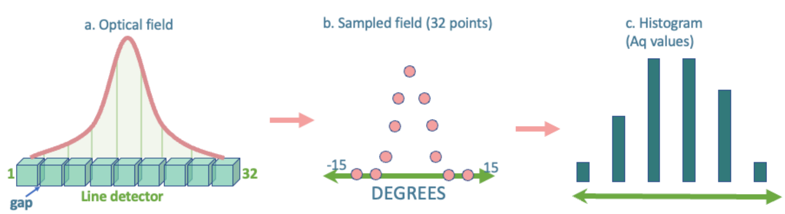

Figure 2.1: a. Optical field definition. b. Window integration. c. Histogram

2.1 Optical field and window integration simulation

The optosurf signal is reconstructed from the 32 sampling points. Such sampling points characterize the roughness of any given sample through the parameters μ and σ. The μ parameter relates to the incoming angle of the sample's reflected light, this is equivalent to a lateral shift of the optical field. The σ parameter relates roughness of the sample and determines the width of the optical field.

This is shown in Figure **??**. When a wafer is rotated the optosurf signal is displaced along the linear detector, while increasing the sample roughness widens the optosurf signal through the σ parameter.

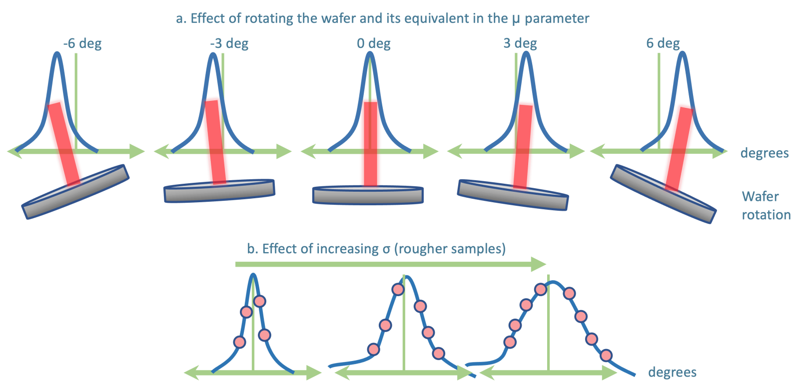

Figure 2.2: a. Effect of changing the angle of the incoming light.
b. Effect of increasing sample roughness

In order to simulate this, the equation of an optical field is defined as:

$y = e^{-((x-\mu)/\sigma)^n}$

Then, different parameters for μ and σ are used to simulate different optical fields over a range of 30 degrees from -15 to 15, as shown in Figure **??** (a). Notice when changing μ from -4.0 to 4.0 the optical field is displaced along the linear detector. When changing σ from 1.0 to 2.5 the optical field is widened.