# ELLIPSOMETRIC IMAGING OF LOW-CONTRAST SURFACE MODIFICATIONS AND DEPOLARIZATION CONTRAST IMAGING (DCI) OF PARTICULATE ACCUMULATIONS

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Imaging of surfaces regarding topographical, morphological, micro-structural, and chemical features is a key requirement for quality control for the identification of contaminated, degraded, damaged or deliberately modified surface areas vs. clean, virgin, undamaged or unmodified regions. As optical functions may represent any of these changes on the micro- and nano-scale, imaging ellipsometry (IE) is the technique of choice using either intensity, phase, or/and amplitude contrast for visualization of low-contrast surface modifications [1, 2].

Defects or surface and film features whether native or artificial, intended or unintended, avoidable or unavoidable as well as surface pattern are of interest for quality control. In contrast to microscopic techniques operated at normal incidence, ellipsometry as oblique-incidence technique provides improved contrast for vertically nano-scaled add-on or sub-off features such as ultra-thin transparent films, metallic island films, carbon-based thin films, laser modification or laser induced damage, dried stain, cleaning agent or polymeric residue.

Two-sample reference techniques, i.e. referenced spectroscopic ellipsometry (RSE) may further increase sensitivity and decrease measurement time. In case of particulate accumulations depolarization contrast imaging (DCI) may improve the lateral resolution beyond the Abbe limit. This has been proven for silica spheres as reference in terms of single particles, particulate accumulations or particulate mono-layers and layer stacks. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used for reference measurements of particle diameter, particle height, or particulate layer/accumulation thickness.

It has been shown that single silica particles of 250 nm in diameter, i.e. at least a factor of 4 better than the lateral resolution limit as of now, can be *visualized* on even substrates. However, the ellipsometric *measurement* of particle diameters of this size needs further efforts interpretation.

*Keywords:* low-contrast surface modifications; particulate distributions; imaging ellipsometry(IE) and depolarization contrast imaging (DCI)

**References**

[1] U. Beck; Imaging of Impurities and Imperfections, Micro- and Nano-scaled Pattern on Surfaces and in Films: Microscopic Techniques vs. Ellipsometry, SVC Santa Clara, CA, USA, April 2015
[2] J. M. Stockmann, A. Hertwig, U. Beck; Applied Surface Science 421(2017)807-812