Images processing tools for data measurements from interferograms

Vsevolod Arnaut, Ion Andrieş

Abstract

The imaging interferometry analyzing methods based on software processing of interferograms possess unique potential capabilities in domain of precise measurements. This paper presents description of software tools designed for processing interferograms obtained by imaging interferometric microscopy methods in order to retrieve transverse and longitudinal linear dimensions and optical properties of objects.

Keywords: optical measurements, interferogram processing, linear dimensions, optical properties, software tools.

1 Introduction

The interferograms are obtained by optical equipments with embedded CCD digital camera and in general case are either optical images of the measured objects with an interference raster superimposed on them, or they are holograms obtained by recording the phase distribution carrying information on the linear dimensions and optical properties of objects. To fully realize the unique capabilities of imaging interferometric microscopy methods in precise and detailed characterization of functional nanometric materials strict mathematical methods, algorithms and software tools are necessary.

This paper presents the description of two software graphical tools. The first of them is designed for interferograms processing in order to retrieve the measurement data of thickness and optical parameters of thin nanometric functional films commonly used in photonics. Interferograms are obtained by conventional microinterferometer MII-4 equipped with a digital camera. The second tool simulates the measurements of linear dimensions by processing of objects images overlaid with an interferometric raster with known period *d*. Images are obtained by a special holographic setup.

2 Used technologies

The mentioned above two kinds of measurements which can be performed are axial measurements and lateral measurements (measurements of longitudinal and transverse dimensions in relation to the direction of the light beam propagation).

Graphical data for axial measurements are obtained from interferometric microscope MII-4 equipped by digital camera. The optical scheme of this microinterferometer is a combination of Michelson interferometer and the microscope (Figure 1).

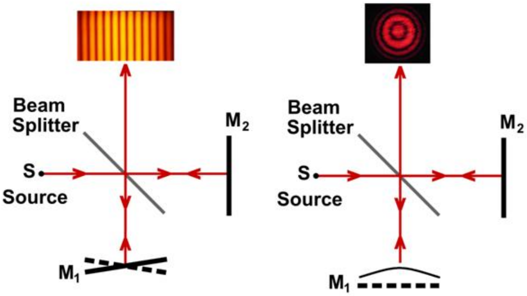


Fig. 1. Microinterferometer optical scheme.

Graphical data represent images of interferograms (Figure 2) obtained from interferometer as a result of direct and reflected beams interference. Because of the thin film cut edge presence (Figure 3), two shifted pictures of interference (Figure 2) are obtained. Measurements performed on the base of images are thickness of opaque thin films, thickness of transparent thin films, refractive index of transparent films. The calculations depends on parameter *b* representing the distance between near fringes and of parameter *c* representing the distance between the fringe and the corresponding shifted one (Figure 2).

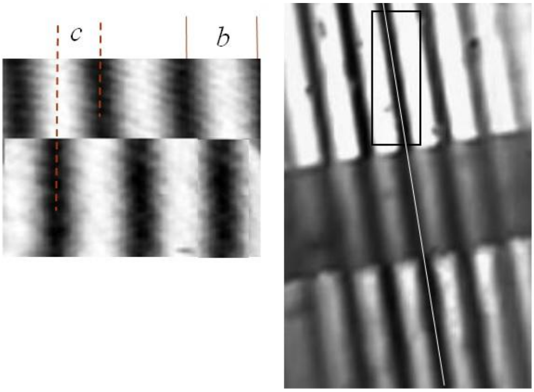
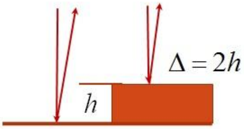
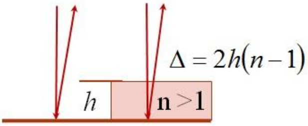


Fig. 2. Examples of interferograms.

Graphical data for lateral measurements also represent interferograms (Figure 4).



1. Opac step



2. Transparent step in reflection

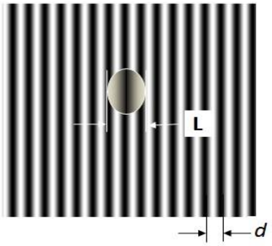
Fig. 3. Cases of opac and transparent films.

3 Graphical tools

Based on the described above algorithms there were developed tools oriented to processing images for retrieval the values of dimensional and optical parameters.

Software tool possesses the following functional possibilities:

- measurement of opaque thin films thickness up to 20-30 nm with a resolution of ~ 5 nm;



$$L = d \cdot \frac{N_L}{N_d}$$

Fig. 4. Algorithm for calculation object size.

- measurement of opaque film thickness with thickness of several wavelengths;
- measurement of transparent film thickness for a given refractive index;
- measurement of refractive index of transparent films at a certain thickness obtained by other measurement methods;
- statistical processing of the measurement results and their storage in a database;
- measurement of objects linear sizes.

4 Conclusion

Compared with conventional layer thickness measuring devices such as profilometers or scanning force microscopes (AFM), this technique provides the full view field of analyzing specimens, is more rapid, noncontact, and does not require complicated specimen preparation. Digital processing of interferograms enables to measure the thickness up to 20 nm with a resolution of ~ 5 nm.

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