EXPERIMENT 7

INTERFEROMETRY

PURPOSE

- To study principles of the light interferometry
- To observe the interference images on the air wedge.
- To evaluate thickness of the thin deposited film using interferometry.

APPARATUS

Metallographic microscope with measuring stage, assembled air-glass wedge, light source, optical filters, dial indicator.

DESCRIPTION OF THE MEASUREMENT

White light from the lamp passes through the coloured optical filter and beam splitter and as the monochromatic beam strikes the air wedge. Investigated thin solid film is deposited (e.g. by vacuum evaporation technique) on the part of the bottom plate of the wedge.
Thereby a step-like topography of its surface is obtained. In the next steps of preparation the reflecting metal (aluminium) film is evaporated on the bottom plate.
To meet requirements of the Tolansky multi-beam interference method also the upper glass plate of the wedge is covered with the semi-permeable reflecting coating.
Both plates are assembled to make an air wedge of small angle with the step of thickness of the air gap due to the boundary of deposited layer.
Rays of monochromatic light, which approach perpendicularly to the wedge are partially reflected back directly from the upper plate while the rest portion of light enters the inner space of the wedge and is reflected back from the lower plate surface. Both parts of the light beam superpose subsequently making an interference image -see Fig 3.
Distribution of obtained fringes corresponds to the homogeneity of air gap thickness. Thus its step-like change due to the deposited thin solid film is represented in interference fringes displacement. The shift value - Δy - depends on the film thickness - h - , adjacent fringes distance - y - and wavelength of the used light.
Assuming refractive index of the air $n = 1$, and small wedge angle - α - the deposited film thickness may be calculated from Eq.1.:

$$h = \frac{\Delta y}{y} \cdot \frac{\lambda}{2} \qquad (1)$$

The distance between the adjacent fringes - y - is given by Eq.2.:

$$y = \frac{\lambda}{2 \cdot \alpha \cdot n} \qquad (2)$$

therefore, it is possible to establish from these measurements the wedge angle - α - value as well.

MEASUREMENTS

1. Turn on the light source.
2. Adjust objective and ocular of the microscope until a sharp image of the interference fringes is obtained.
3. Find the region of the displacement of dark stripes.
4. Make measurements of :
   i. fringes distance - y -
   ii. shift value Δy

   for the series of at least 15 readouts.
   In this purpose:
   i. adjust the position of the stage (with the screw) until cross-hair line matches chosen dark stripe.
   Record the micrometer dial readout – r_1 -
   ii. move the stage to the next stripe position.
   Record new dial value - r_2 - .
   The difference $(r_1 - r_2)$ gives the fringes distance - y - value.

   Similarly make the - Δy - values measurements.

5. Change the coloured filter in the light source tube . Repeat procedure in step 4 .

   Record all results on the data sheet.

CALCULATIONS AND PRESENTATION OF THE RESULTS.

1. Calculate the average fringes distance y and the average shift value Δy for each light wavelength used.
2. Calculate the thickness - h - of deposited layer from Eq. 1. using average y_m and Δy_m values for each experimental wavelength ; put :
   λ= 625 [nm] for red filter
   λ = 545[nm] for green filter.
3. Calculate the mean value - h - for each light wavelength.
4. Calculate the 95% confidence intervals -δy - and - $\delta \Delta y$ - using Student's distribution method with corresponding correction factor t (see part II - Lab. Data Analysis).
5. Calculate the absolute error - Δh - from:

$$\Delta h = h\left(\frac{\delta y}{y} + \frac{\delta \Delta y}{\Delta y}\right)$$

6. Calculate the wedge angle - α - from Eq. 2. putting the mean distance value - y_m.

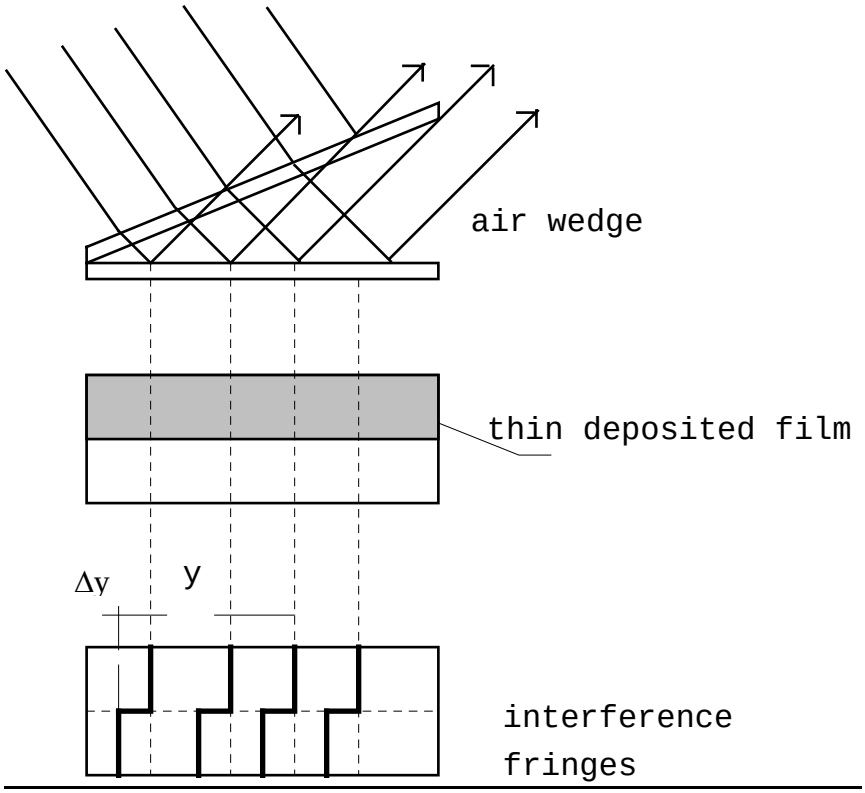

Figure 1.

ANALYSIS AND INTERPRETATION

1. Compare results of thickness obtained for different wavelengths of the light.
2. Present the final result in a form:

$$h = h \pm \Delta h$$

DATA TABLE

Stripe number ***m***	distance ***y [m]***	displacement ***Δy [m]***	thickness ***h [m]***

REQUIREMENTS

1. Description of the interference images in thin films (the air wedge., Newtonian rings)
2. Principles of establishing deposited film's thickness from interferometric method.