FYSS330: Microscopy and Lithography

Examination 31.5 2011

The max. points to be gained are indicated at the end of each question.

1. Explain briefly the following (8 p):

a) Cartesian oval
b) Fluorescence microscopy
c) Field emission
d) Magnetic force microscopy
e) Phase shift mask
f) Resists
g) Extreme ultraviolet lithography
h) Projection lithography

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2. Aberration mechanisms in optical lenses. (4p)

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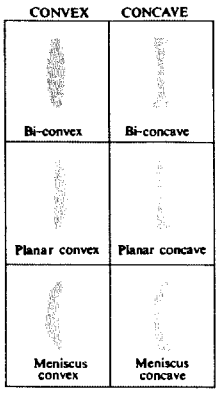
3. Take a thin planar-convex lens, having a radius of curvature of 50 mm on the convex side and an index of refraction of 1.5.



Calculate:

a) the focal length with light entering from the planar side and from the convex side. (3p)

b) the image point (s_i) when the object is at distances 600, 200, 150, 100, and 50 mm. (3p)

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4. The Scanning electron microscope and electron beam lithography. Draw a picture that contains the essential elements of the SEM. Discuss the SEM thoroughly (both as imaging and analytical tool) and how it is used for lithography. (6p)

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5. The figure below shows data from an experiment where an AFM tip is pressed against three different films (A-C). On the X-axis is the height of the tip above the surface so that at negative x-values the tip presses into the films. On the Y-axis is the resulting deflection of the tip-holding cantilever as it is forced towards the film.

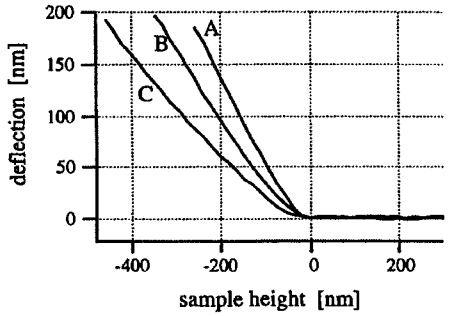

Figure 3. Three force curves taken at locations of a film thickness of 150 nm (curve A), 410 nm (curve B), and 1.15 μm (curve C). At high forces, the force curves are steeper for small thicknesses because the cantilever deflection is influenced by the underlying stiff substrate at these small film thicknesses. For comparing the slopes more easily, the curves are shifted such that their points of contact coincide.

The cantilever spring constant is k_t. Assume that the force resulting from the contact between the tip and the film is elastic and can be described with a spring constant k_S. Explain how one can obtain from the data information on the elasticity of the films. Give the equation that gives such information via the spring constants. (6p)