Introduction

- Displacement Talbot Lithography (DTL), also known as PHABLE™, is a new photolithographic technology for printing periodic patterns with sub-micron resolution.
- In PHABLE™, either amplitude or phase masks can be used.
- Phase masks enable higher contrast images and higher throughput.
- Masks for PHABLE™ are generally produced by serial e-beam or laser writing techniques followed by an etching step.
- Here we demonstrate that phase masks for PHABLE™ can be alternatively produced with a nanoimprint process from serially written masters.
- No etching is required since the imprinted material is used directly as the phase shifting material.

Displacement Talbot Lithography (DTL)

- Periodic pattern in the mask
- Monochromatic illumination
- Formation of "self-images" of mask pattern at regular distances separated by the Talbot period
- "Self-images," however, have a limited depth of focus
- Vertical displacement of wafer by the Talbot period during the exposure
- Result: high-contrast, time-integrated image, independent of initial separation of mask and wafer
- Therefore, effectively infinite "depth of focus"
- Ability to print high-resolution patterns onto poor flatness substrates

Phase mask fabrication with NIL

- A Si stamp with a hexagonal array of holes is used as the master in the imprint process. The Si stamp is itself created with a PHABLE™ exposure.
- UV-assisted imprint performed into a resist that has low absorption of UV-light, e.g. Ormostamp™.
- The imprinted resist pattern on a quartz substrate can be directly used as a phase mask in a PHABLE™ system. The refractive index of Ormostamp™ at 400 nm is 1.56.

Potential applications

- LED
- Photovoltaics
- Display

Phase mask in DTL exposure

- Photoresist pattern exposed in a PHABLE system using the imprinted phase mask.
- The combination of imprinted phase masks and DTL creates high-contrast images in photoresist.

Talbot effect

- Vertical displacement of wafer by the Talbot period during the exposure
- Result: high-contrast, time-integrated image, independent of initial separation of mask and wafer
- Therefore, effectively infinite "depth of focus"
- Ability to print high-resolution patterns onto poor flatness substrates

Mask efficiency:

- 0th order: 17.7%
- Sum of 1st order: 71.6%

Transmission measurements on the imprinted phase mask show that 0th order light is strongly suppressed.