35 nm half pitch step and repeat imprinting utilizing polymeric stamps from EUV-IL fabricated templates

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Introduction

Step and repeat imprint lithography replicates small areas (called dies) of a wafer at a time and then moves to a new area of the wafer. The process is repeated until the entire wafer is imprinted. Using step-and-repeat imprint lithography, templates can be used to pattern a much larger substrate (e.g., 200 mm wafer up to 300 mm) in fractions of an hour instead of several days. One advantage of the step-and-repeat method is the achievable higher alignment accuracy on smaller areas than on larger areas. A second advantage, and probably the most significant for many applications, is that it allows the use of small high resolution templates to create large area imprints. Herein we report on imprinting of 35 nm half pitch line and space structures from a template fabricated by extreme ultraviolet interference lithography (EUV-IL). This template was replicated in a polymer working stamp and imprinted in a step & repeat (S&R) mode.

Eulitha Master Fabrication

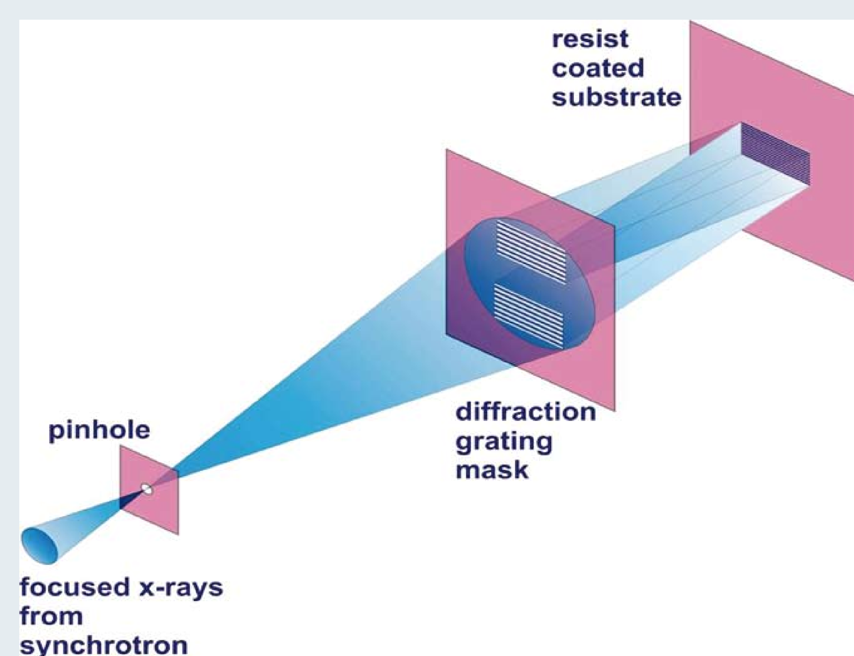


Figure 1: Basic principle of extreme ultraviolet interference lithography

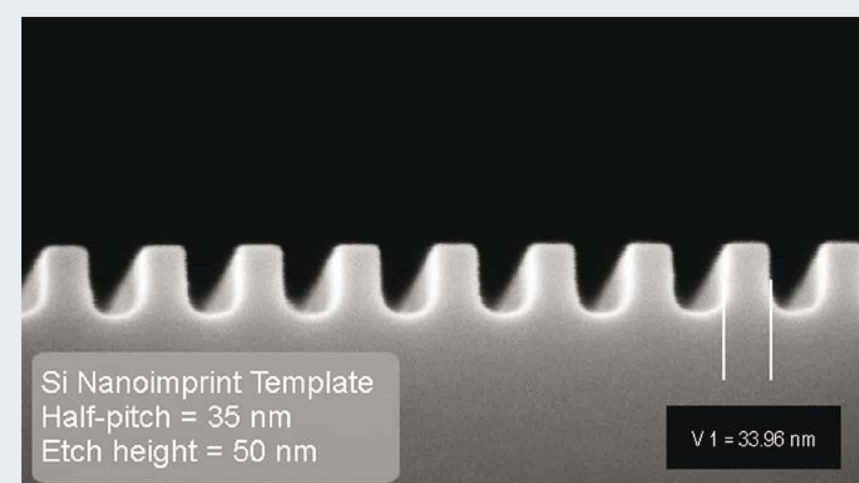


Figure 2: SEM image of Si nanoimprint template

EULITHA's Extreme Ultraviolet Interference Lithography (EUV-IL) is a revolutionary technology for the high-throughput fabrication of periodic nano-patterns with half pitch below 50 nm. The interfering beams are obtained from a single EUV beam by transmission diffraction gratings. For example, when two beams are interfering on two parallel positioned diffraction gratings the observed grating period is equal to half of the period of the diffraction gratings.

Stamp Fabrication

A polymeric stamp was fabricated from the EUV-IL master for the subsequent step and repeat imprint process. Its main advantages are based on its high transparency, flexibility and low surface energy, which do not require surface treatment due to the anti sticking nature of the molecule end groups.

Master Template

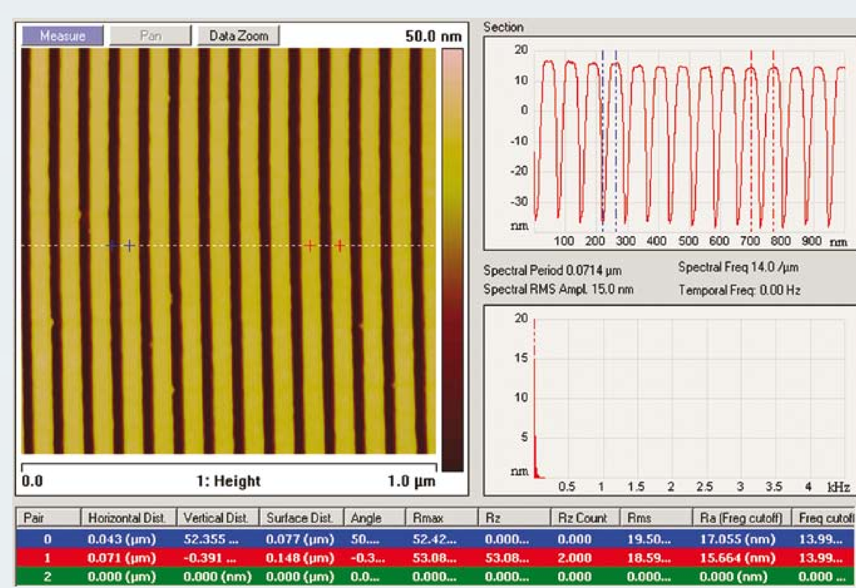


Figure 3: Atomic force microscope (AFM) image of 35 nm half pitch EUV-IL master template

Corresponding Working Stamp

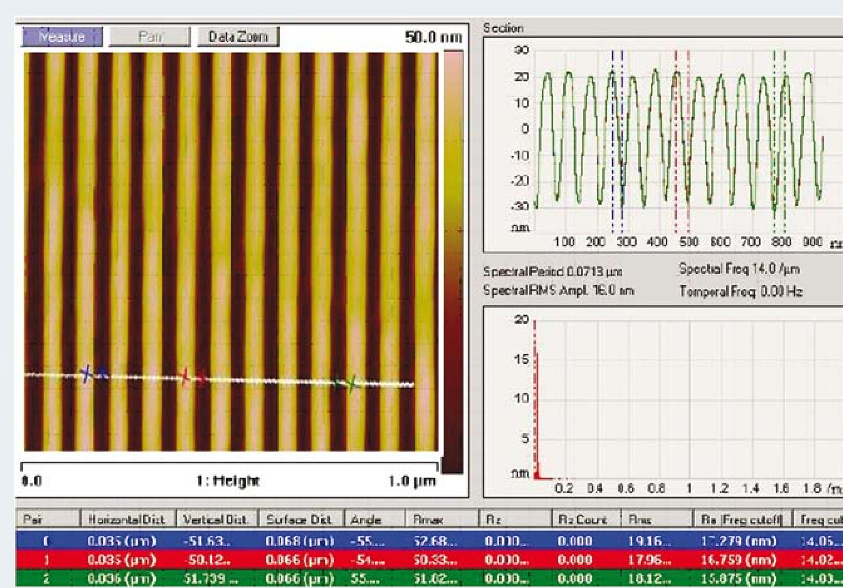


Figure 4: Atomic force microscope (AFM) image of corresponding 35 nm half pitch polymeric working stamp

Step and Repeat System

The specific parameters of the EVG 770 Automated NIL Stepper:

- Vacuum imprinting
- High precision alignment (± 500 nm)
- Fine Alignment: 50nm (optional)
- Measurement units for embossing / de-embossing forces
- Fully automated template loading/unloading

Figure 5: Photograph of an EVG 770 NIL Stepper

Imprint Results

Residual layer

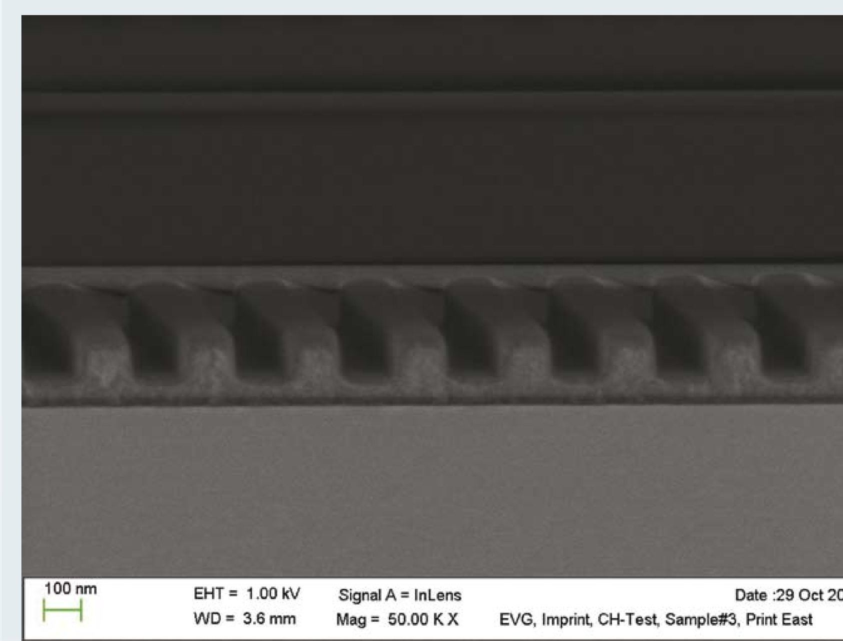


Figure 6: SEM Image of residual layer uniformity on step and repeat imprinted die

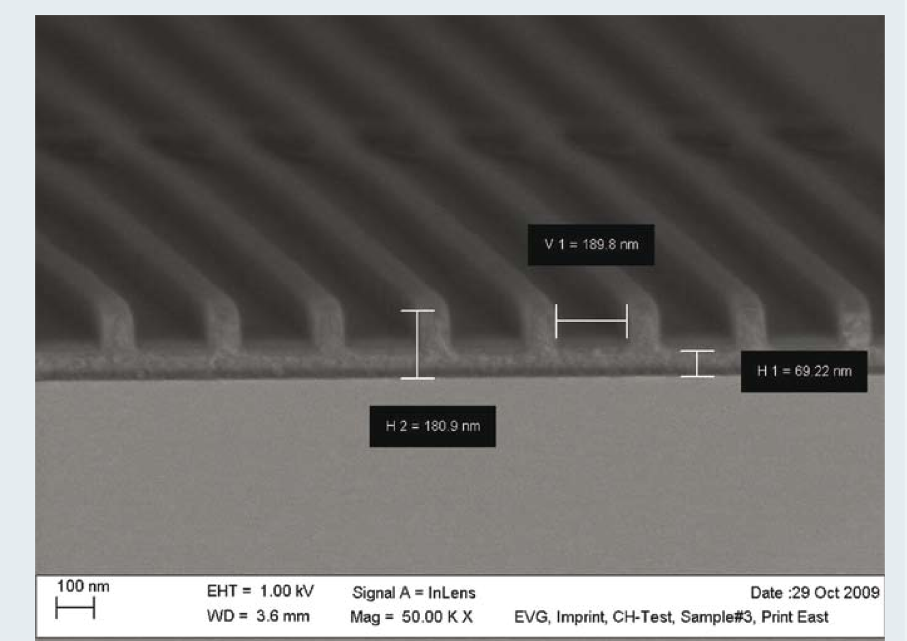
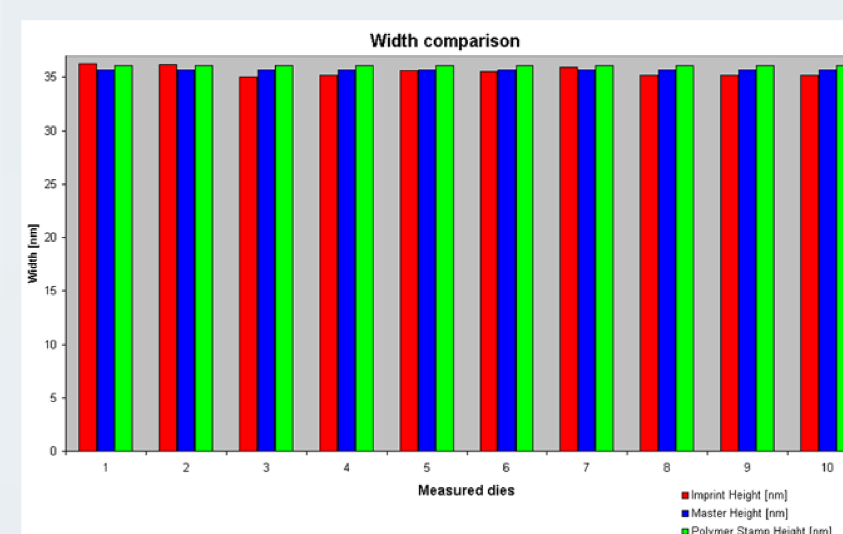


Figure 7: SEM Image of residual layer uniformity on step and repeat imprinted die

Pattern fidelity



Width comparison of master template/corresponding working stamp/imprinted die

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