# Metrology of Sub-65nm Resist Gratings on a Flexible Substrate Fabricated by Jet and Flash Nanoimprint Lithography[1]

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Roll-to-Roll nanoimprint lithography is widely in use today in industry because of its high throughput and low cost. Therefore, rapid, non-contact metrology technologies for the imprint process are critical for extending this technology. To ensure a good final result following the etching and deposition processes, it is very important to monitor the quality of resist gratings just after the imprint. However, due to the properties of the flexible polymer substrate, most standard metrology tools, like SEM or OCD, cannot provide a clear image of the resist grating.

Scatterometry is a solution to this problem. It is a fast, in-line, non-contact, non-destructive nanoscale metrology tool. The reflection is measured at various incident angles (12° - 80°) from the grating surface normal for the four combinations of TE/TM polarization and grating orientation parallel and perpendicular to the plane of incidence. The sample has a resist grating on a flexible polycarbonate substrate. The grating profile is assumed to be a simple trapezoid structure and is defined by four parameters (pitch, bottom-width, top-width, and resist thickness). Simulation is run by rigorous coupled wave analysis (RCWA), creating a library to compare with experiment. The fitting process is based on comparing simulation with measurement to determine the detailed parameters.

A 405 nm laser is used as the light source. The grating master which is used to make the roll-to-roll resist grating is a 100 nm deep, 65 nm half-pitch grating. Figure 1 shows the AFM image of the roll-to-roll resist grating and Table I shows the comparison of scatterometry and AFM readings. All of the parameters of scatterometry and AFM are matched nicely. AFM readings (shown in Figure 2) are always convolutions of the actual size of the artifact and the dimensions of the tip. A simple correction based on the known tip dimensions has been applied to the AFM results. Scatterometry shows closer results to the master grating parameters.

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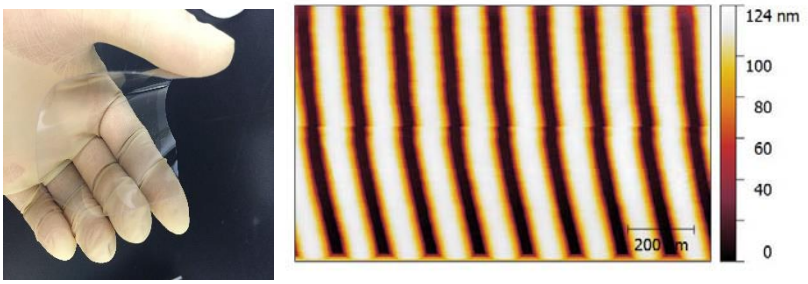


Figure 1: Flexible polarizer and AFM image of resist gratings on flexible substrate made by Roll-to-Roll Jet and Flash Nanoimprint tools

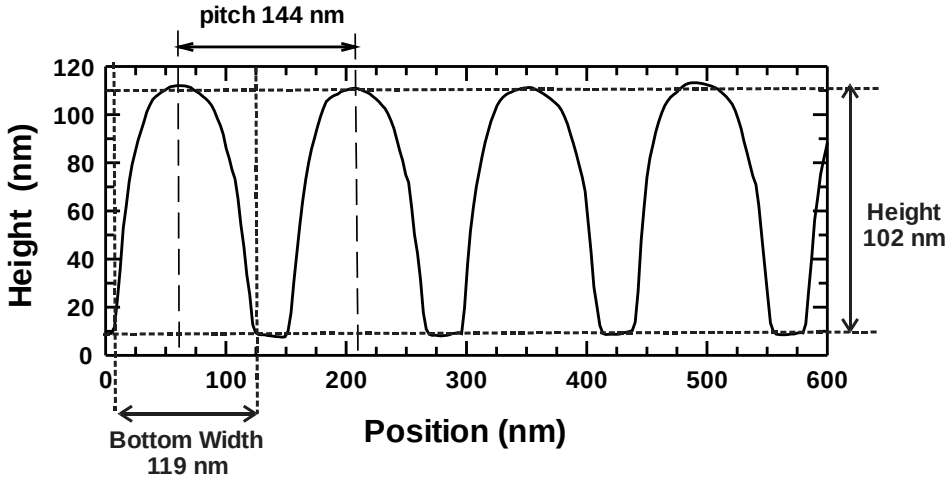


Figure 2: AFM image analysis

Figure 3: Scatterometry fitting results of TM and TE polarization

| | Pitch | Linewidth | Topwidth | Thickness | Residual Resist Layer |
|---|---|---|---|---|---|
| Scatterometry | 129.6 | 82.0 | 77.0 | 92.0 | 10.0 |
| AFM | 144.0 | 119-2$\delta$ | NA | 102.0 | NA |
| Master Grating | 130.0 | 65.0 | 65 | ~100.0 | NA |

Table I: Comparison of scatterometry, AFM and master grating parameters. $\delta$ is the width of the tip at the grating height.