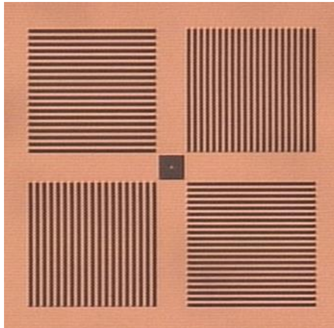
SMFL Users News Letter – Number 140122 V5.2

This News Letter is intended to provide information of interest to MicroE faculty and other users of the SMFL. It is a report on equipment and processes used in the SMFL with emphasis on changes, problems, and details that may not be generally available to users. I distribute this to the MicroE faculty and others. If you feel that this News Letter has some information that might be useful to your graduate students please forward it to them. Past newsletters are posted on Dr. Fuller's webpage.

ASML Issues:

ASML Wafer Alignment Basics: The ASML aligns the wafer using alignment marks on the wafer that realize a reflective diffraction grating. The mark is has x and y oriented lines and spaces L/S of 8um/8 um and also 8.8um/8.8um shown below.

ASML alignment marks used on Wafer, Mask and Stage



These marks are placed on the wafer in various locations typically on the left and right side of the wafer. The marks are etched into the wafer to a depth that will result in a high contrast diffraction pattern. The marks are illuminated with a HeNe laser and the resulting diffraction pattern is transferred through the stepper lens (at 5X) to the mask where it is superimposed on similar marks on the mask. The stage is moved in x and y to find the stage location for best superposition. This is done for at least two marks for example one on the left and one on the right side of the wafer. From these measurement calculations are made for rotation (Theta) correction and for the stage location for each exposure.

To get high contrast alignment marks the height difference in the alignment mark should be such that the optical path length is ¼ of the HeNe wavelength which would result in ½ wavelength reflection difference or 180° phase shift giving high contrast dark lines. This means the height difference H should be λ / 4 n where λ is the wavelength and n is the index of refraction of the material immediately above the wafer. If the material is photoresist then n= 1.6 to 1.7 and H = 632.8 / 4 / 1.65 giving H = 96.0nm or 960Å.

The Issues:

A couple of weeks ago the stepper was doing alignment with no problems. After the PM (Preventive Maintanence) visit from ASML the stepper would not align the same wafers that worked a few weeks ago rejecting them always (Ivan's wafers) or sometimes (Josh and JP's wafers)

Verification of the problem:

The problem was verified using different wafers that worked months ago. They also always failed.

The Solution:

The problem was slightly complicated. First, the verification was done incorrectly because the wafers that were used were not coated with photoresist. Therefore the contrast of the diffraction pattern was not correct and all the wafers were rejected. (incorrect $H = \lambda / 4 n$)

Once the problem was realized and the wafers were coated with photoresist, those wafers all aligned with no errors. However, the wafers that were started weeks ago still were rejected. Ivan's always, Josh and JP's sometimes.

Stephanie Bolster has several years' experience working for ASML and working with the ASML stepper at RIT. The ASML stepper creates a history file for every wafer it tries to expose. Stephanie was able to recall the history files for the wafers in question from before the PM and after the PM she was able to determine that the rejected wafers were rejected because the Theta adjustment during alignment exceeded the specified tolerance. The ASML default tolerance for Theta adjustment is 300 micro radians. If the calculated required Theta adjustment is above this value the wafers are rejected. Before the PM Ivan's wafers required about 50 micro radians rotation and after the PM 305 micro radians. Josh and J.P's wafers had values of about 25 before and about 280 after. (close enough that sometimes the wafers were rejected)

The PM resets the tool to match the performance with ASML calibration wafers from months ago. The alignment marks on wafers started a few weeks ago were not in the optimum location due to small drifting in the performance of the flat finder and other settings.

Stephanie was able to set the tolerance for Theta adjustment to 400 micro radians in the machine parameters. This will not affect anything but will allow Ivan's, Josh and JP's wafers to not fail for too large of a Theta. If our PM's were more frequent the drifts might be smaller and these types of problems might not occur.

As of today all is working well with our ASML stepper.

More Information on our ASML Stepper is available on my webpage:

http://people.rit.edu/lffeee/steppers.htm