Visual Test Light Scattering Reticle

Users Guide

Floppy Disk Contents

Filename

4INVTW:
5INVTW:
6INVTW:

4", 5", and 6" reticle data for producing a Visual Test Wafer. This wafer contains both horizontal and vertical patterns used to visually determine stepper focus and repeating defect checks

4INLSW:
5INLSW:
6INLSW:

4", 5", and 6" reticle data for producing a Light Scattering Wafer. This wafer contains diagnal patterns used to scatter light during a "frosty wafer" reticle load routine.

4INCOMBO:
5INCOMBO:
6INCOMBO:

4", 5", and 6" reticle data for producing a Combination Visual Test / Light Scattering Wafer. This wafer contains Horizontal, Vertical, and Diagonal patterns used to visually determine stepper focus and repeating defect checks, and also to scatter light during a "frosty wafer" reticle load routine.

4INHORIZ:
5INHORIZ:
6INHORIZ:

4", 5", and 6" reticle data for producing a Visual Test Horizontal Patterned Wafer. This wafer contains horizontal patterns used to visually determine stepper focus and repeating defect checks

4INVERT:
5INVERT:
6INVERT:

4", 5", and 6" reticle data for producing a Visual Test Wafer. This wafer contains vertical patterns used to visually determine stepper focus and repeating defect checks

VTLSR USERS GUIDE

Introduction:

Stepper Equipment Inc. is proud to present the Visual Test/Light Scattering Reticle (VTLSR). The VTLSR is designed to provide a twofold use of creating a visual focus test plus having the ability to generate a light scattering pattern that loads product and test reticles alike. Both of these functions can be produced on a simple resist coated ultraflat wafer. This manual is dedicated to provide you (the user) information to effectively generate a visual focus test that saves time with daily stepper checkouts and reduce cost by giving you the ability to generate your own frosty wafers.

The VTLSR has three fields, each covering the maximum area rectangle (30mm X 10mm) on an Ultratech widefield lens. The first and second fields contain horizontal and vertical line and space dimensions specified to match the resolution capability of your lens*. The third field contains features designed to create images that scatter light during frosty wafer reticle loads.

* Lens specification determines which critical dimension VTLSR should be used (i.e. A lens specified at 1.25 micron should use the 1.25 micron Visual Test Light Scattering Reticle – P/N = VTLSR-1.25A).

About the Visual Test:

Visual Test images are diffraction grating patterns that show focus variation when printed on a resist coated wafer. As stepper focus drifts away from nominal, the Visual Test wafer image will become non-uniform showing discoloration that is easy to determine. Unlike Short Step Focus, these images show focus variation not only across an exposure field but also across an entire wafer.

Inspection is performed without a microscope (visual 1X inspection); as a result, the user can determine focus quality of a stepper within seconds of having the test wafer developed (thus saving considerable test time). With proper training, the user can define focus failures and follow up with appropriate corrections in minimal time having the assurance stepper focus is nominal when complete.

Visual Test images can also be used to detect repeating defects in the image field. These defects are usually caused by:

1. Dust motes on the upper or lower prism
2. Dust motes on the illuminator optics
3. Dust motes on the reticle or pellicle
4. Glass scratches or imperfections on the upper or lower prisms (scratches and sleeks from cleaning on the anti-reflective coatings on the upper and lower prisms usually do not scatter light enough to cause printing defects)

Inspection of repeating defects is performed without a microscope (visual 1X inspection) in most cases.

How to characterize the Visual Test for printing defects:

Characterization must begin by insuring that the light path on the target stepper is free from dust motes:

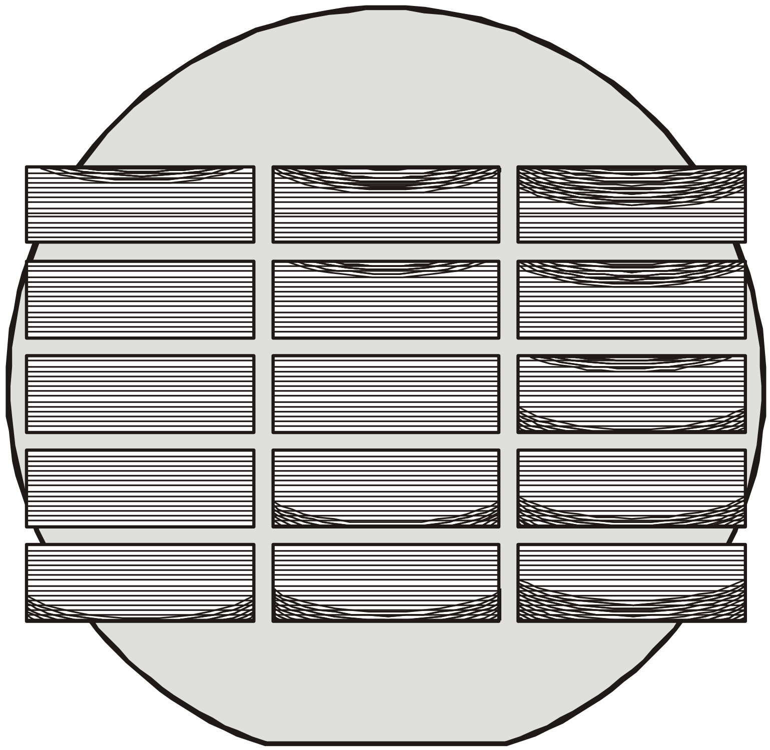
1. Clean the upper and lower prism with clean, dry, filtered air. If this is not sufficient to remove all visible particles, follow the lens cleaning procedure in your maintenance manual for particle removal from the system optics.
2. Clean the VTLSR reticle with lens tissue and acetone. Make sure to use a new sheet of tissue for each swipe of the reticle. Do not re-use the tissue as this will re-deposit particles removed during the 1st swipe.

Create a Visual Test Wafer using the supplied reticle data (*VTW). Create this wafer by blind-stepping (run mode #1) a focus setup wafer with the VTLSR reticle.

Inspect each field on the wafer carefully, both with and without a microscope, and look for defects that repeat in every field. If you find a repeating defect, note the location in the field, and re-examine the upper and lower prisms for dust motes. Clean as necessary and repeat this procedure until your VTLSR wafer is defect free.

How to characterize the Visual Test for focus issues:

Characterization must begin by choosing a reference stepper and optimizing machine focus (focus centered using SSF to within +/- .5 um). Chuck flatness must also be optimal to maintain consistent images across the entire wafer as the focus plane passes through the useable depth of field. Once accomplished, focus/exposure matrix tests can be run to identify depth of focus generated by the chosen exposure energy. The following figure is a typical example of how a focus/exposure matrix pattern will look with a horizontal field Visual Test image:



Focus / exposure matrix
using VTLSR reticle

A note about setting exposure for the Visual Test:

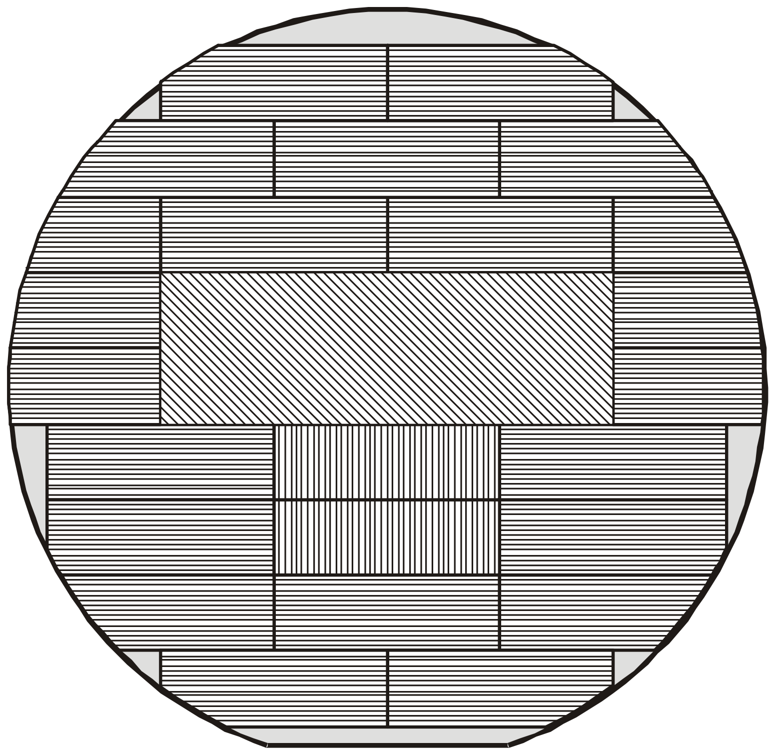
Establishing proper exposure is vital in determining operational “boundaries” of the VTLSR. The individual beginning development of the Visual Test must establish an exposure energy that closely matches critical layer CD’s. Ideally, exposure should be set to generate a 1:1 image on the wafer (i.e. reticle CD’s match wafer CD’s). If the Visual Test image is overexposed, the useable depth of field is greatly reduced. In other words, slight changes in focus (less than spec) will cause the Visual Test image to look unacceptable. Underexposing the Visual Test wafer usually makes interpretation much more difficult to determine. Therefore, it is very important to come up with an exposure that allows the Visual Test image to look acceptable through its operational depth of focus.

Combining images on a Visual Test wafer:

The VTLSR contains vertical and horizontal features to help with identifying astigmatic effects of a stepper lens. Lens astigmatism causes horizontal and vertical lines to come into focus at different planes. Combining both features can reduce the overall depth of field that is printed.

By combining images of the VTLSR on a single test wafer, several functions can be accomplished at the same time. Printing horizontal and vertical fields on one wafer will identify if focus is within tolerance for both features.

Additionally, by adding a Light Scattering image, reticles can be loaded using the frosty wafer routine (see Light Scattering image description in succeeding paragraphs). The following figure is what the combined Visual Test/Light Scattering wafer looks like:



Normal VTLSR Wafer
with Frosty Pattern

Another useful feature of combining images on the same wafer is helping the user locate any printable repetitive defects. Repetitive defects are typically caused by particles, scratches, or contamination located on the reticle or prism surface. The Visual Test image will show any of these defects and can be seen by 1X inspection.

The "Gray Area"

Generally, Visual Test images are easy to determine if stepper focus is acceptable or unacceptable. However, there are times a wafer may become difficult to interpret due to the Visual Test image being in the "gray area". The gray area is a point that wafer focus approaches an out of tolerance condition yet is still acceptable to process critical features. At this position of focus, the image does not look pristine as it would if perfectly centered. However, attempting to correct focus may prove to be futile and yield no less image quality. To eliminate potential interpretation problems, it is necessary to establish boundary Visual Test wafers that define acceptable and unacceptable focus outside the gray area.

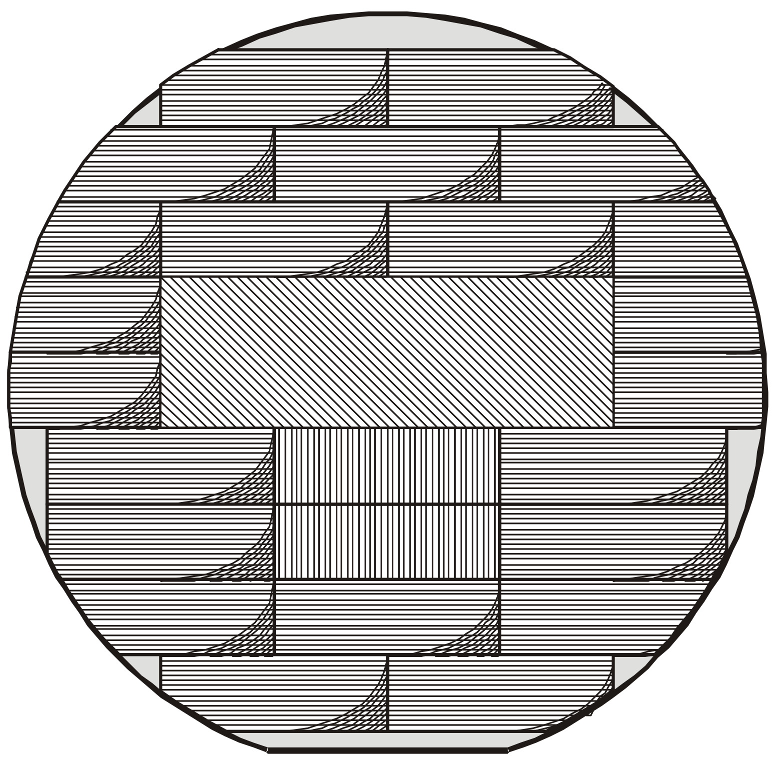
To create boundary or limit wafers:

- Optimize stepper focus as previously described.
- Expose Visual Test images using nominal exposure.
- Optimize the Visual Test wafer (correct as necessary).
- Expose series of Visual Test wafers using .5 micron focus offsets passing through useable depth of field (typically starting with –2.5 micron offsets to +2.5 micron offsets)
- Retain wafers that exhibit acceptable focus boundaries (user defined).
- Place boundary wafers in a location that can be viewed by the personnel performing regular Visual Test checkouts.

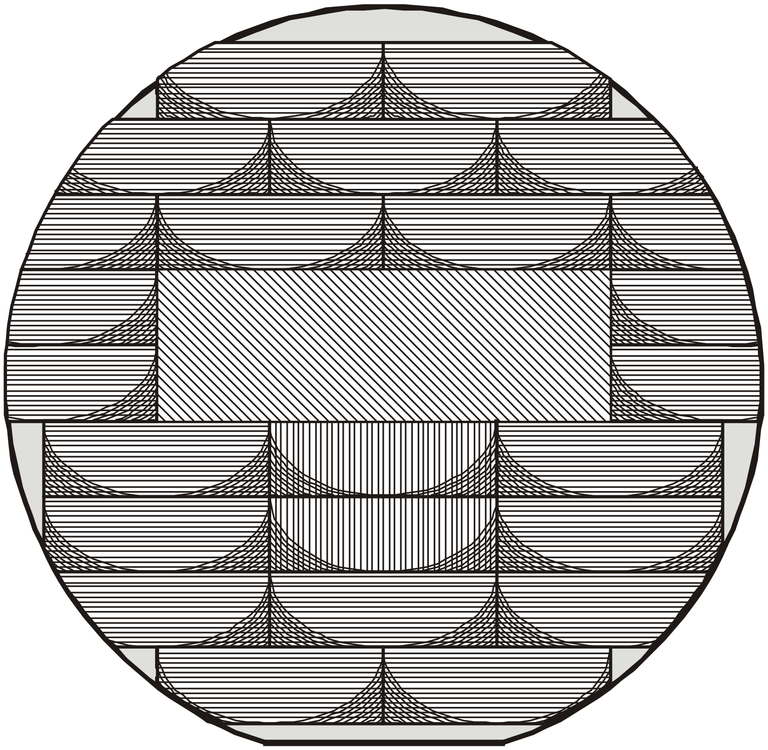
Production operators and technicians can use the boundary wafer examples to determine whether Visual Test passes on any given stepper being tested.

How to interpret Visual Test wafers:

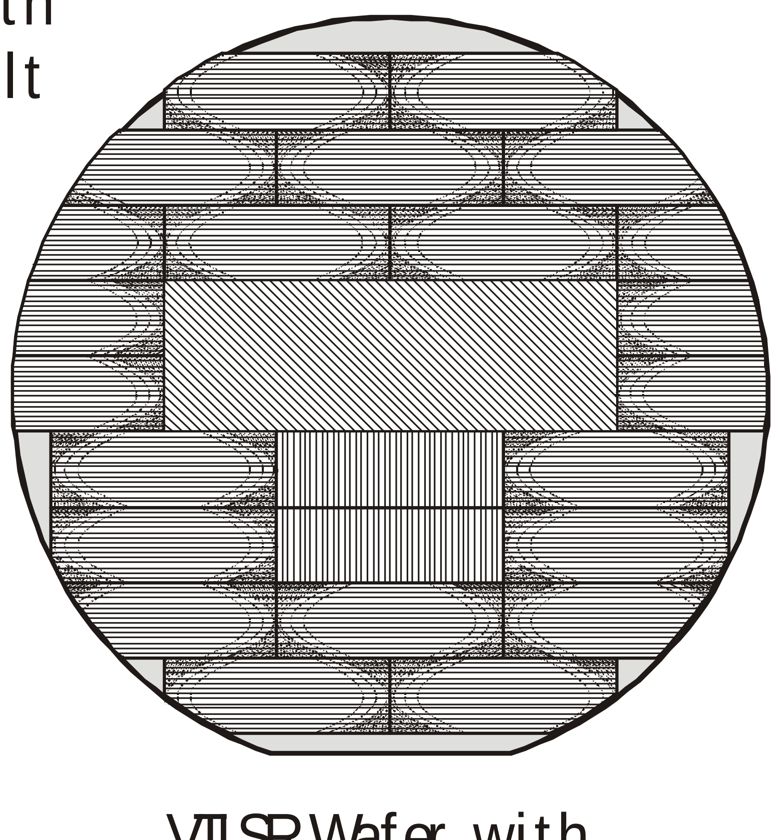
Interpreting Visual Test wafers is a subjective method of determining focus. As a result, it is important to learn the necessary skills to accurately assess image quality of the Visual Test wafer. Using a vacuum wand, hold the wafer in a position that reflects an image of a light source (usually an overhead florescent bulb). Tilt the wafer to a position that highlights the Visual Test images (rotating the wafer 90 degrees can also improve images being viewed). Compare the Visual Test wafer with boundary wafers (if available) to determine whether focus is acceptable or unacceptable (also inspect for focus tilt, offsets, contamination on chuck, repeaters, etc.). The following examples are what Visual Test images look like during out of focus conditions:



VTLSR Wafer with horizontal tilt



VTLSR Wafer with
Front / Back Tilt



VTLSR Wafer with
focus offset, No tilt

The following summarizes inspection criteria:

- Compare Visual Test wafer to known good and bad reference wafers.
- Make determination of acceptable or unacceptable focus condition.
- Retain passing wafer on stepper for future reference.**

**One advantage of retaining the test wafer by the stepper being tested is having a fingerprint of focus performance visually available for any user to observe.

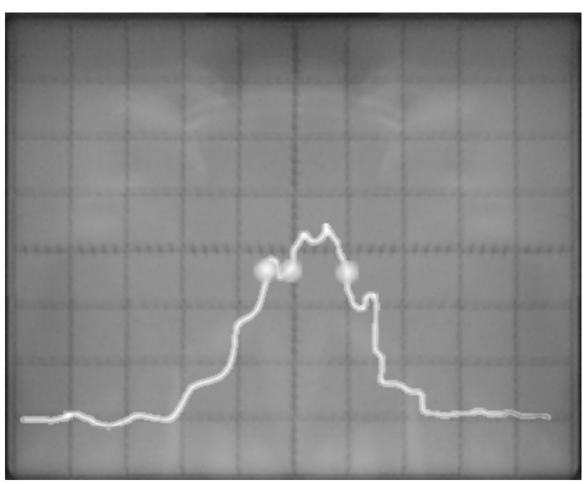
Implementing Visual Test:

After the initial characterization is complete, systematically test your remaining steppers to establish best and worst focus conditions (this will also allow you to collect reference wafers showing specific failures). Take the most chronic performing stepper and make the necessary corrections to optimize the printed image. Continue with each stepper until all systems are performing to the desired standards and develop the necessary documentation to integrate the Visual Test into your daily checkouts. During the correction phase, document what was done to improve the Visual Test. Append the documented corrective actions to a reference wafer library and display in a location for the maintenance and production personnel to refer to. Doing so will improve the learning curve of Visual Test dramatically.

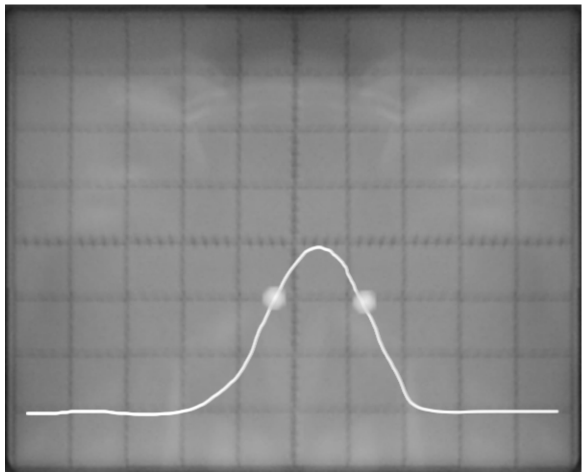
About the Light Scattering image:

The second function of the VTLSR is to produce an exceptionally uniform light scattering image for frosty wafer reticle loads. The Light Scattering image not only improves reticle load accuracy but also reduces cost of purchasing and/or producing acceptable frosty wafers. The most cost-effective way of making the Light Scattering image can be done with a resist coated wafer integrated into the Visual Test pattern as described in previous text. The area that contains the Light Scattering image is sufficient to scatter light from reticle fiducials to the darkfield alignment system of your Ultratech Stepper.

Many frosty wafers are made by depositing metal/oxide substrates on a wafer to create a light scattering surface for the darkfield alignment system of the Ultratech stepper. Methods of using wafer backsides or other surface preparations that scatter light have been attempted with limited success. Unfortunately, the light scattering capability of these methods is either inadequate or non-uniform and frequently results in problems with the reticle load routine. The following figure shows a typical scanning trace with standard type frosty wafers:



As you can see, the scan has a very rough trace that causes inaccurate threshold sampling of the reticle fiducial position. This often makes the reticle keys misalign to the crossmasks of the darkfield alignment system. When this occurs, target scanning is greatly affected and product misalignment is the result. By cleaning up the reticle alignment signal, sampling of the fiducial position is improved and placement of the reticle keys to the crossmasks is more accurate. The next figure shows the improved scan produced by the Light Scattering image:



In summary, the VTLSR is designed as a tool to diagnose focus problems and generate light scattering images to improve reticle load accuracy. Experience shows significant process improvement can result with successful implementation. Please feel free to give us a call if you should have any questions or need assistance with this valuable tool.

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