Application Note

DSA20060404:

Reticle Repeater Analysis and Filter

FEATURES

- Reticle Repeater Analysis
- Reticle Repeater Filter

SiGlaz

Introduction

This application note discusses the two primary methods to identify reticle repeating defects in the KLARF file. These techniques may be used in the "analysis mode" to view the defects that meet the repeater parameters, or in "filter mode," which allows the users to keep, remove or classify the identified repeaters.

Reticle repeaters may occur as a result of several different effects in the lithography process, for example:

1. Reticle damage or small particulates on the reticle may cause isolated repeaters;
2. Wafer distortion and clamping issues may result in focus spots;
3. Film deposits or bacteria growth on the reticle may cause reticle shading defects.

These repeating defects may be identified using two different signature analysis methods. One of the methods may have an advantage over the others depending on the type of reticle repeater and the level of background defects, which might generate false positives.

The first method is to identify repeaters by looking for individual defects that are located at the same relative location of multiple reticle fields within a specified proximity radius. The location of the reticle fields may be defined by a reticle layout file or by a library file. An algorithm to eliminate false positives may be applied to this technique.

The second method is to use object signature analysis to identify groups of objects that have a centroid with the same X location or Y location.

Reticle repeater analysis using reticle layout file or library file

In the first example, Repeater Test 02.000 is a KLARF with a single isolated defect as a result of a particulate on the reticle. The reticle layout file for the wafer is shown below. This is a good application for analysis by reticle layout file or library file because the repeater type is an isolated defect. *Figure 1* (below) shows that the reticle layout file specifies 52 reticle fields; this number will used to determine the percentage of fields affected.

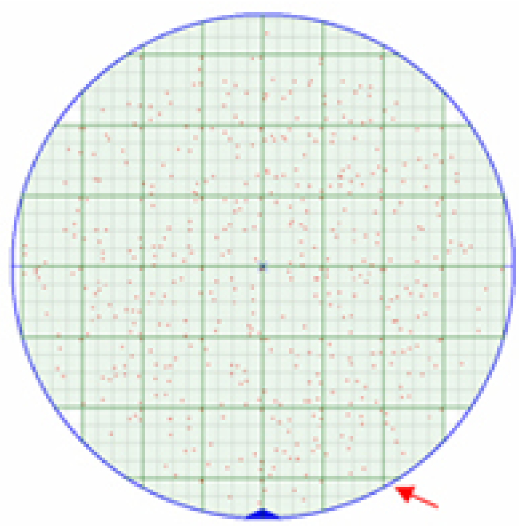

Figure 1: Reticle Layout File

It should be noted that there are twelve small areas at the edge of the wafer that are not covered by the reticle layout file. (The red arrow is pointing to one of these areas.) If the reticle library file is used to define the reticle fields, there will be 64 reticle fields. The twelve areas not counted in the reticle layout file are considered to be fields in the library file, even if none of the dies in those fields is inspected. For example, if there are 26 reticle fields affected by a repeater, analysis by reticle layout file will report that 50% of the fields are affected; analysis by library file will report that 41% of the fields are affected (26/64).

For repeater analysis using reticle layout file, the proximity radius for the repeater is set to 400 microns and the repeater frequency is set to 80%. The result of the analysis is shown in *Figure 2* below; the initial file is shown on the left; the identified repeaters are shown on the right. To achieve the same results using the reticle library file, the repeater frequency must be reduced to 65%.

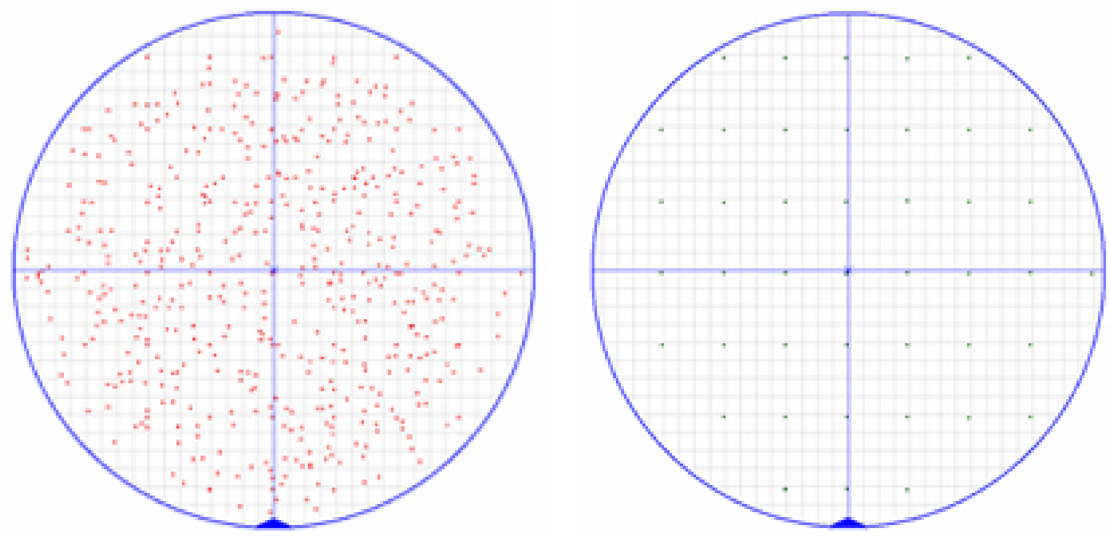

Figure 2: KLARF Repeater Test 02.000 is shown on left; results of repeater analysis are shown on right.

When the same repeater analysis technique is used on a KLARF with a focus spot repeater (for example, Repeater Test 02.000), the repeater frequency parameter is reduced, compared to isolated repeater, because the focus spot is often limited to a portion of the wafer. The results in *Figure 3* (below) are shown for a reticle layout file with the proximity radius set to 500 microns and the repeater frequency is set to 40%. Although the majority of the focus spots are identified, the complete spots in the upper left quadrant are not identified.

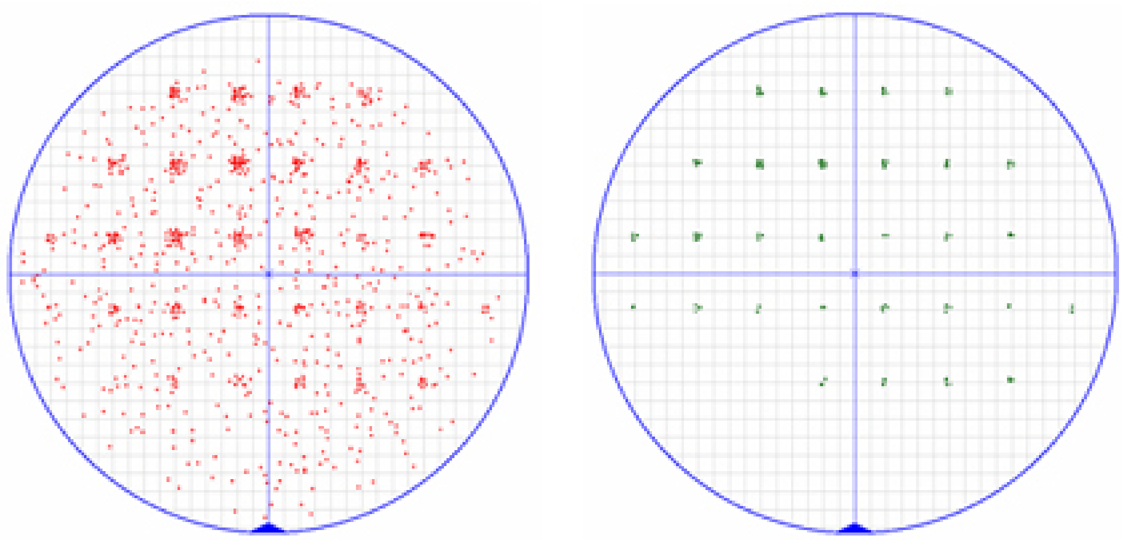

Figure 3: KLARF Repeater Test 03.000 is shown on left; results of repeater analysis are shown on right.

To capture the complete spot using this method would require increasing the proximity radius and reducing the repeater frequency; however, this is likely to also generate some false positives as shown in *Figure 4* below. The repeater parameters for the analysis shown are: proximity radius: 1000 microns; repeater frequency: 10%.

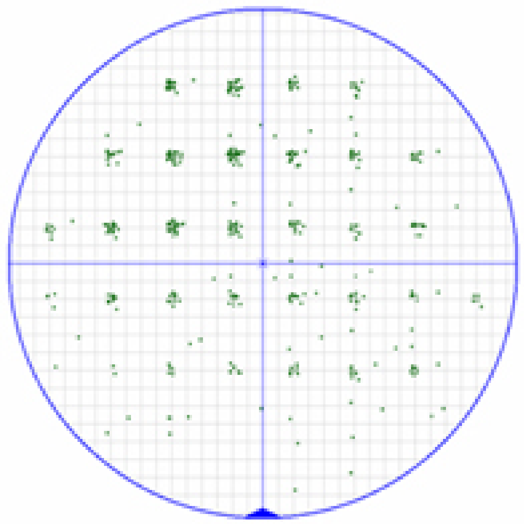

Figure 4: Repeater Test 03.000 analysis results with relaxed proximity radiusand repeater frequency captures complete focus spots; however, false positives are also apparent.

Repeater Analysis using Object Signature Recognition

Repeater Analysis using Object Signature Recognition works very well for repeating signatures like focus spots because the repeating signature is a small object located in the same relative position of each reticle field. The objects can be identified as repeaters by using the “Group By Condition” of the Signature Analyzer/Filter.

In the example *Repeater Test 03.000*, the Signature Analyzer parameters are set as follows:

Range of Defect Count	**Filter Conditions**
Min: 20	Den Shape Major Length > 1000
Max: 2000	Den Shape Major Length < 20000
Processing Parameter	Den Shape Major Minor Ratio < 3
Neighbor Distance: 5	**Group By Conditions**
Density: 1	X Centroid Location: Min: 4
Number of units > 3	Delta: 2000
	Percentage of Total Analyzed Defects: 20%

The processing parameters and filter conditions will identify all small clusters that fit the profile of the focus spot. The “group by” parameter requires that at least four clusters have a density shape X centroid location within 2000 microns to be considered a repeater. At times, these parameter settings will miss repeaters with only three clusters at the same X centroid location, but this issue can be addressed by repeating the signature analysis with Y centroid “group by condition,” and then ORing the results together. *Figure 5* shows the results of the signature analysis with both X and Y centroid “group by” parameters.

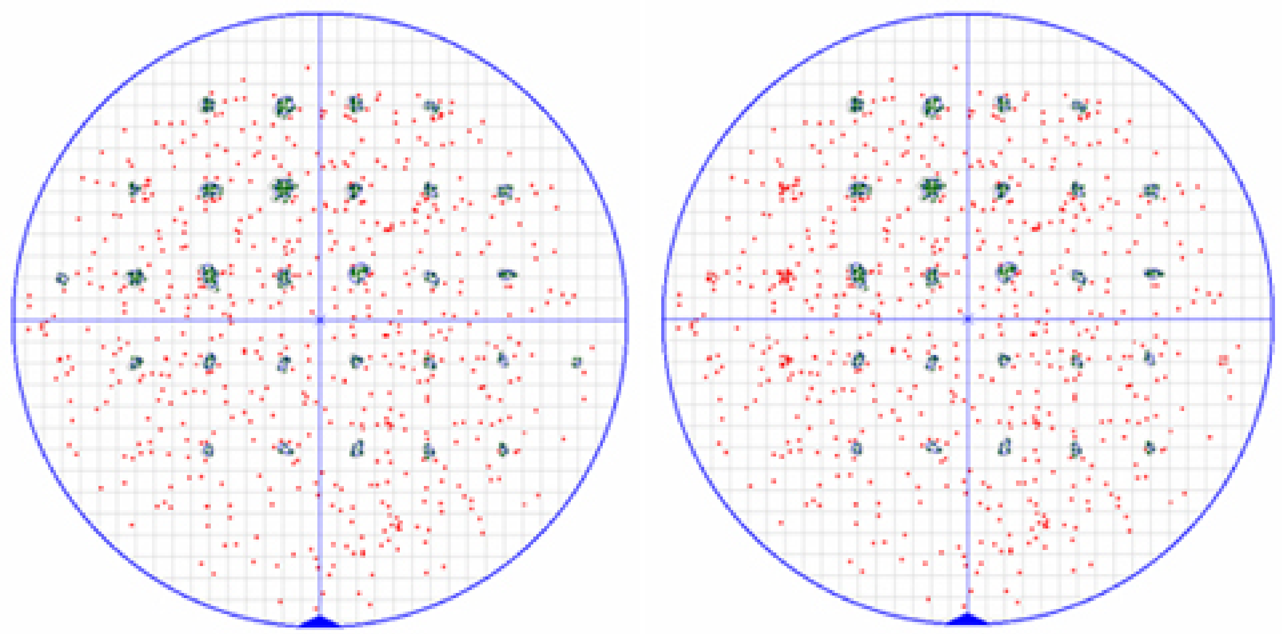

Figure 5: Repeater Analysis using Object Signature Recognition; wafer on left shows results with X centroid grouping; wafer on right shows wafer with Y centroid grouping. The two results can be ORed together to capture all repeaters.

The X and Y centroid locations of the density shape are the only parameters that are available in current version of IDA for repeater analysis. In future releases of IDA, the user will be able to perform "multi-object analysis" to determine that there is another cluster within a specified X or Y distance. This will improve both the accuracy and purity of the current repeater analysis capability.