Defect Inspection for High Volume Patterned Media

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The Jet and Flash Imprint Lithography (J-FIL^{TM}) process uses drop dispensing of UV curable resists for high resolution patterning. Several applications, including patterned media, are better, and more economically served by a full substrate patterning process since the alignment requirements are minimal. Patterned media is particularly challenging because of the aggressive feature sizes necessary to achieve storage densities required for manufacturing beyond the current technology of perpendicular recording. In this paper, the ability to inspect patterned templates and disks is addressed.

The patterning process starts with the fabrication of a Master Template. A high resolution electron beam resist, such ZEP520A is used to define the bit array. Since the pattern is radially symmetric, a rotary stage e-beam tool is required. Both subtractive and additive processes can then be used to form relief images in the fused silica substrate. The Master Template is replicated by imprinting onto a blank fused silica wafer. After transferring the pattern into the substrate, the Replica Template can then be used to print on disks to create the patterned media. Examples of both discrete track patterns and servo patterns are shown in Figure 1.

It is critical to understand the impact on yield by monitoring the defectivity of both the template and the imprinted disk. This work presents a methodology for automated pattern inspection and defect classification for imprint-patterned media. Candela CS20 and 6120 tools from KLA-Tencor map the optical properties of the disk surface, producing high-resolution grayscale images of surface reflectivity, scattered light, phase shift, etc. A schematic of a Candela inspection system is shown in Figure 2. We have developed software that analyzes these images and identifies defect pixels distinctly from the pixels that correspond to data storage structures or servo patterns. Defects that have been identified in this manner are further characterized according to the morphology of the defect pixels as well as the defect location on the substrate.

Figures 3a and 3b show typical specular scans of two disks from an imprint run. Figure 3c depicts a magnified view of both media and the servo tracks. Defects detected by the inspection tool are reviewed with an SEM in order to identify the defect type. Using this methodology, it then becomes possible to track defectivity from the template to the disk and from disk to disk.

As an example, the defectivity of the two disks shown in Figure 3 is compared both to each other and to template used for imprinting. The results are shown in Figure 4. Captured are the original defects on the template and various defects resulting from the imprint process. The scanned area of the template and disks was 29 cm^2. The two most common imprint defects are particle induced defects and non-fill defects. The graph always shows which defects are common among the three substrates. This paper will cover the capability of the inspection tool, defect comparisons across several imprinted disks during an extended imprint run and will also present additional examples of defects captured on both templates and disks.

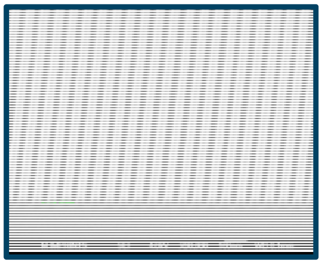


Figure 1. a) 32nm HP tracks

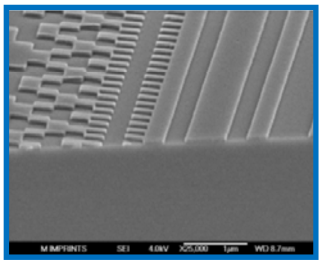


Figure 1. b) Track address

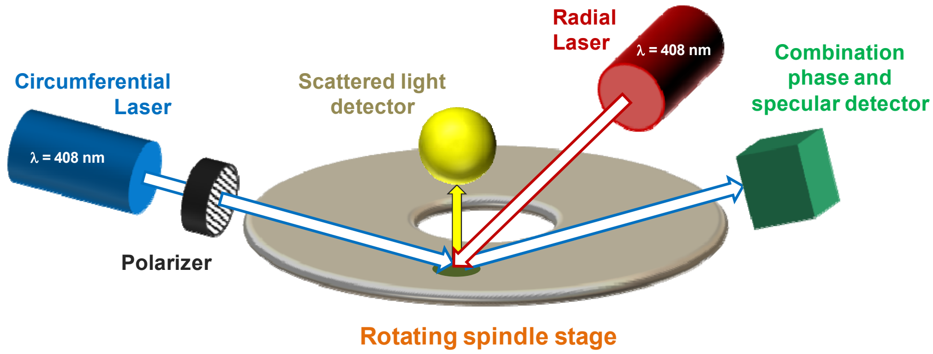
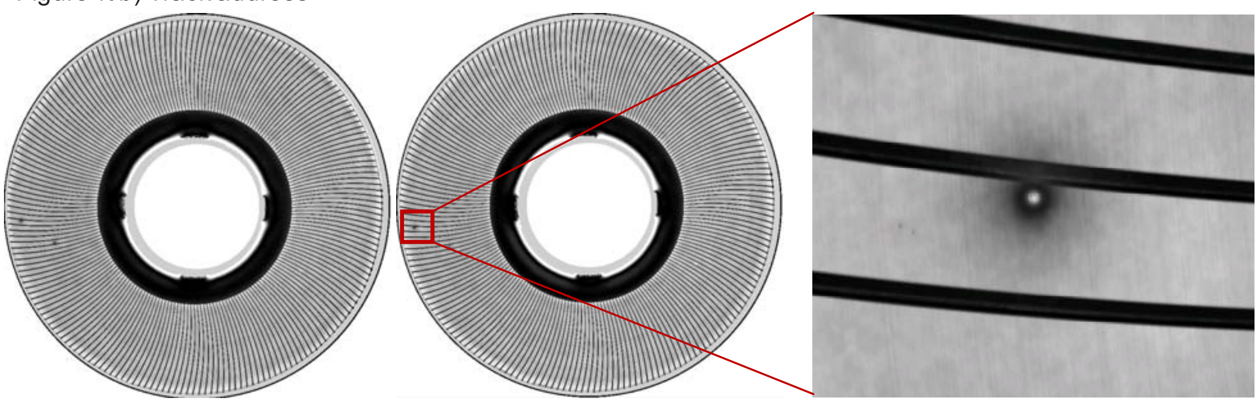


Figure 2.) Schematic of optical components in a Candela® inspection tool (KLA-Tencor, Inc.).



a b c

Figure 3. a) and b) Candela scan of two disks from an imprint run. c) A magnified scan showing a defect resulting from a particle on the disk.

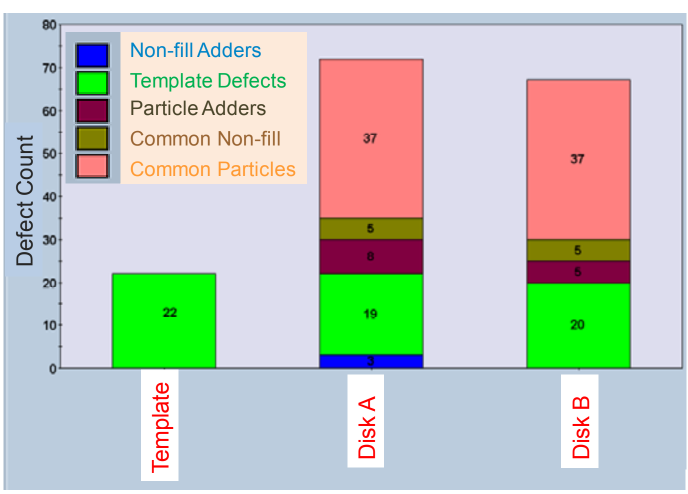


Figure 4. Defectivity from a template and two imprinted disks. Defectivity is tracked using Candela-based inspection tools. Total inspected area is 29 cm^2. Defect types are confirmed via SEM inspection. Most of the defects induced by particles are common to both disks. A few non-fill defects are also detected.