
Circular Path Surface Topography Measurements for Computer Disk Media

Including Examples of Glass Disk Circular Waviness

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Introduction

The measurement of surface roughness and the examination of the associated roughness parameters are important for ensuring disk performance. Examples of the parameters which reveal valuable information about the disk surface include: surface roughness; peak and valley depth measurements (glass and Aluminum disks); and disk duboff (or surface edge roll-off).

Chapman Instruments profilers also have the ability to be used for another application for the disk industry: circumferential measurements. The term circumferential measurement means that the data is acquired in a circular path around the disk. Combined with Chapman's automated staging, this feature can automatically measure multiple locations at several disk radii in a circumferential direction.

The advantage of measuring in a circumferential direction is to provide surface topography information along the same path that the read-write head uses as it flies over the disk surface. This is important for examining the disk surface height relative to manufacturing specifications to ensure good signal strength for reading and writing data. Chapman provides data analysis to resolve both small lateral features (commonly called roughness) to wider features (waviness) comparable to the dimensions of the read-write head. Chapman's vertical resolution of better than 0.01 nM allows confidence in the surface topography measurements.

Method

The method used for this measurement combines the Nomarski-based measurement principle associated with Chapman's family of profilers and a rotary stage. In this measurement, the profiler head is kept stationary while the disk moves on a precision rotary stage. Chapman's basic measurement principle is insensitive to vibration, and thus allows repeatable measurements either with the upper linear stage for radial measurements or with the lower rotational stage for circumferential measurements. The Windows-based SurfaceVision software allows users to pre-program multiple scan locations and parameters. After loading the disk, the operator only needs to select one key to acquire several scans and plot the data.

Measurements can be made either in a defined arc around the disk or in a complete rotation around the disk. The length of a scan around the disk is dependent on the radius of the measurement location. For example, at a 30 mm radius, an entire measurement around the disk would be 188.4 mm. Chapman's profiles maintain the same high spatial resolution regardless of scan length. Thus, a measurement around the entire disk contains both roughness and waviness information.

Measurement Results

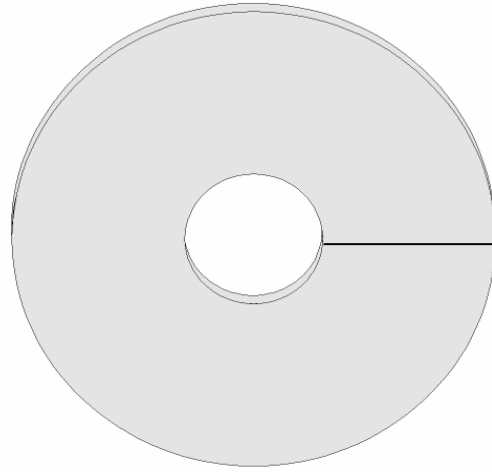
The enclosed data plots (Figure 1) show the measurement configurations for either linear or circumferential direction on a disk. Circumferential measurements can be done 360 degrees around the disk. Multiple circumferential measurements can be set up for automated data.

- ◆ A "short" 5mm linear scan.
- ◆ One ID-OD Scan
- ◆ Eight ID-OD Scan
- ◆ One Circumferential Measurement

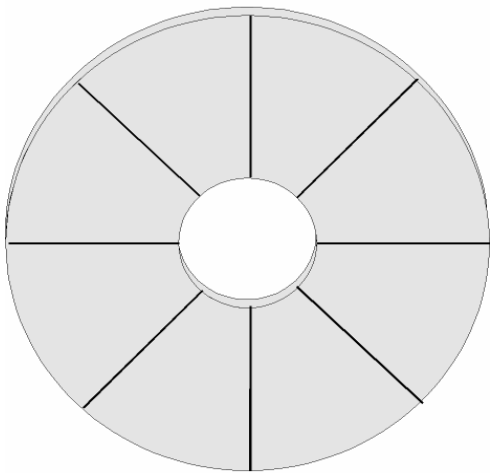
Disk Measurement Geometries



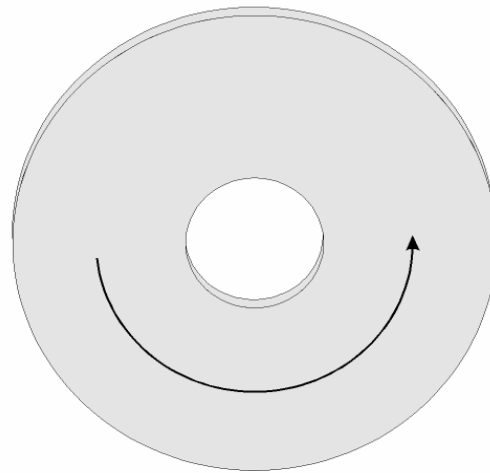
A "short" 5 mm scan.



ID to OD measurement.



Eight ID to OD measurements
with automated positioner.



Circumferential measurement.

Figure 1

Figure 1 shows a graphical representation of the locations of several scans, both linear and circumferential.

Figure 2 shows an example of two repeat circular scans, 360 degrees around the wafer. The data is configured to show results for three filters:

- Filter 1: 100 to 500 μm
- Filter 2: 100 to 1000 μm
- Filter 3: 100 to 3000 μm .

These three filters are only examples, configured to cover the spatial dimensions near the read/write head. The measurement data in Figure 2 shows the data from the two scans displayed over the 360 degree circular repeat path with a filter of 100 to 3000 μm . The data shows good repeatability over the measurement length. The data from all three filters is shown in the Chapman SurfaceVision spreadsheet, part of the overall software. The roughness parameters of Ra, RMS (Rq) and Rpm and Rvm are shown on the data spreadsheet for both repeat scans.

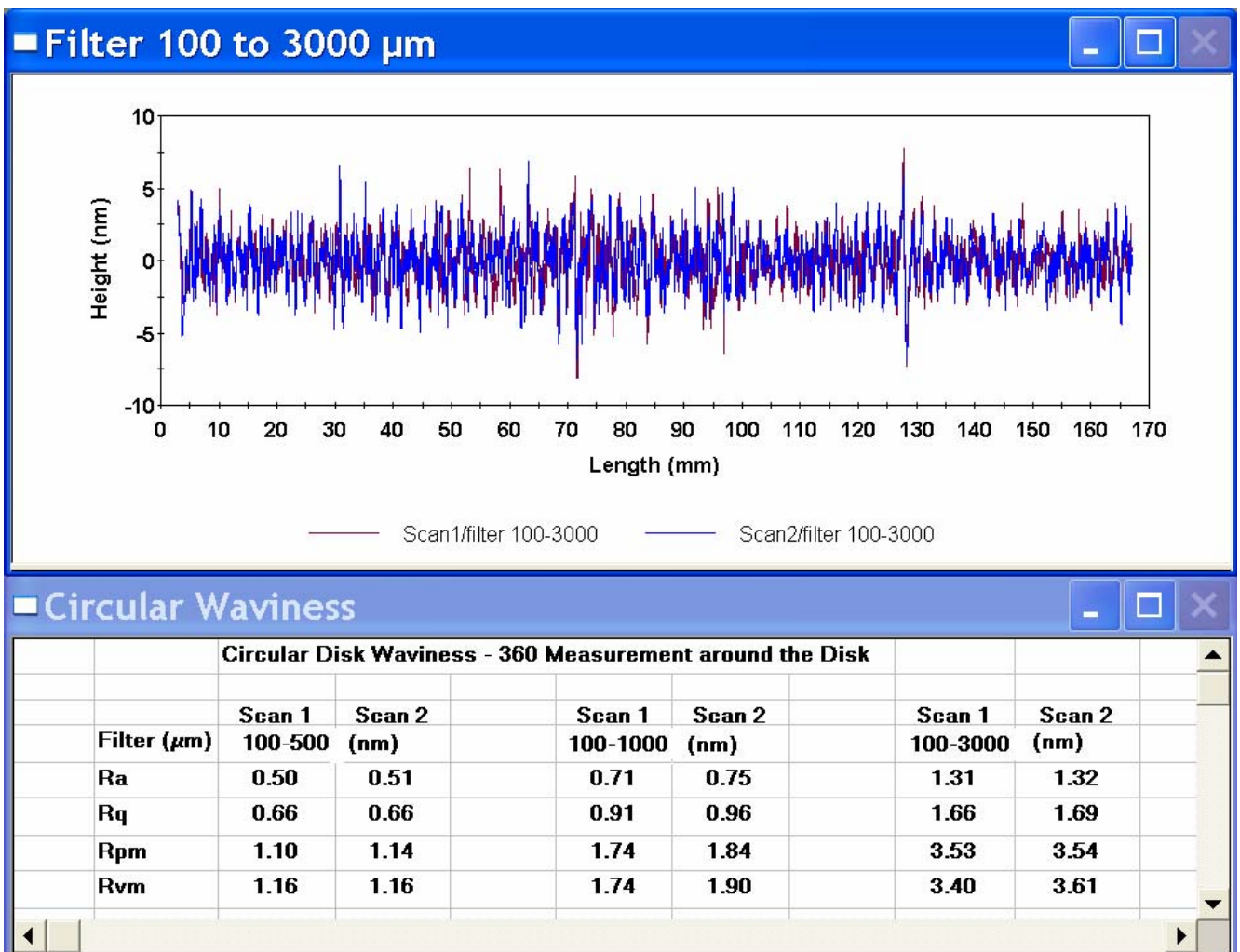


Figure 2: Shows the roughness data for the 100-3000 μm filter on two repeat 360 degree scans around a glass disk. The location was at a radius of 28mm. The scan data above shows good repeatability. Four roughness statistics are shown for three filters. The four roughness statistics are Ra, Rq (RMS), Rpm and Rvm. Rpm and Rvm are averaged peak and valley heights.

The surface waviness data is one method to show the surface features with the statistics of Ra and Rq. An alternative method is to show the power spectrum, which displays the Rq (RMS) roughness over all spatial frequencies. Figure 3 shows the power spectrum from the two repeat scans 360 degrees around the disk.

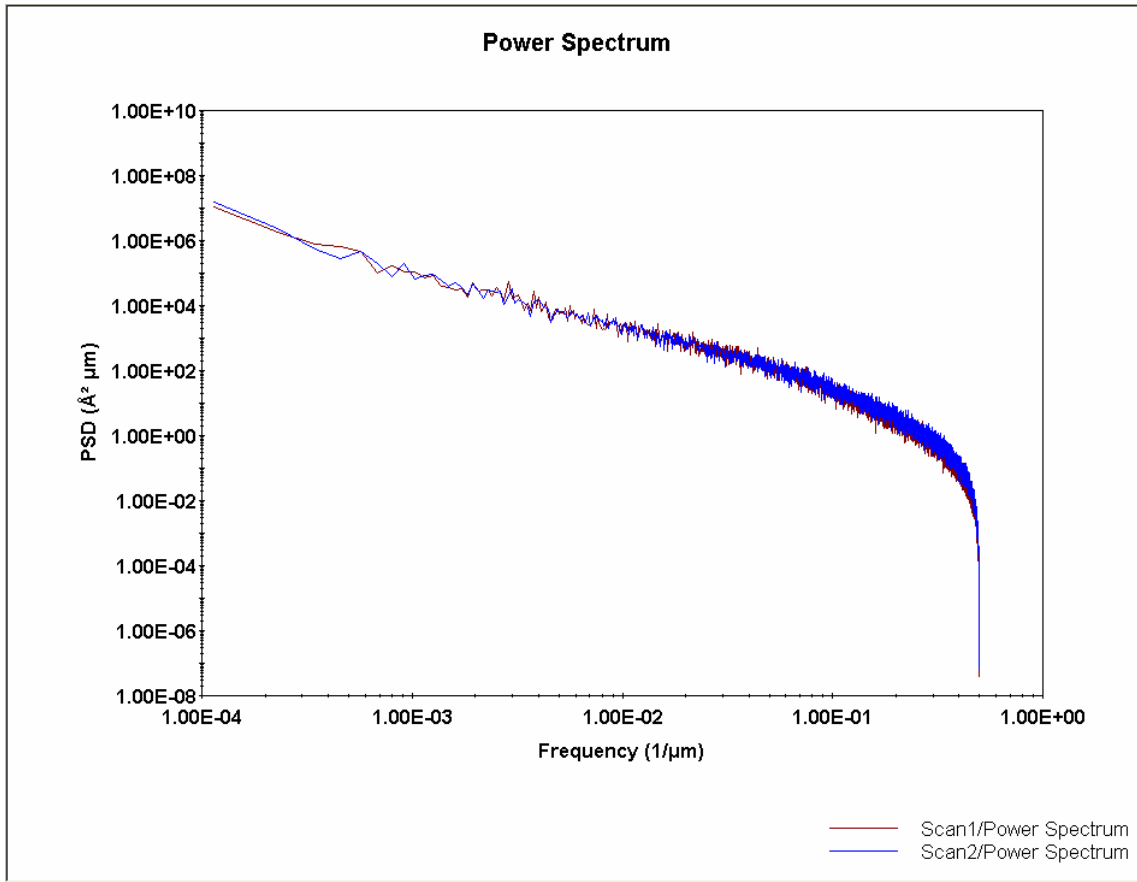


Figure 3: The power spectrum for the two repeat scans is shown in the graph. The power spectrum shows the Rq (RMS) value as a function of the spatial frequency.

Conclusion

A test was made to compare repeat scans on a circular scan 360 degrees around a glass disk. The test shows good capability and repeatability for these measurements. Data can be acquired at any radius on a glass or Aluminum disk. Also both roughness and waviness can be analyzed with several different filters from the same scan data.