Chapman Instruments

Nanotopography of Silicon Wafers

Using the Chapman Non-Contact Profiling System

By, Baishi Wang

Concern over local wafer site flatness for advanced lithography has led to new wafer surface topography requirements. These requirements are typically driven by CMP where film thickness variations can result in un-even surface topography. Control over local wafer site flatness becomes important for device geometries smaller than 0.25 µm. The industry definition of nanotopography covers a spatial wavelength range of approximately 0.2 to 20 mm. This region essentially defines surface topography dimension larger than roughness. Roughness is defined as the smaller size spatial features on the wafer (an analogy to grains of sand in the desert), while nanotopology defines wider features up to approximately a lithographic field site (an analogy to sand dunes - wider and taller than grains of sand). The measurement statistic for nanotopography is the peak to valley, representing the total "out of flatness" over a field site. Typically features as small as 20 nm can cause local CMP non-uniformity. Figure 1 shows the concept of surface topography irregularities over three different spatial regions of microroughness, nanotopography, and flatness.

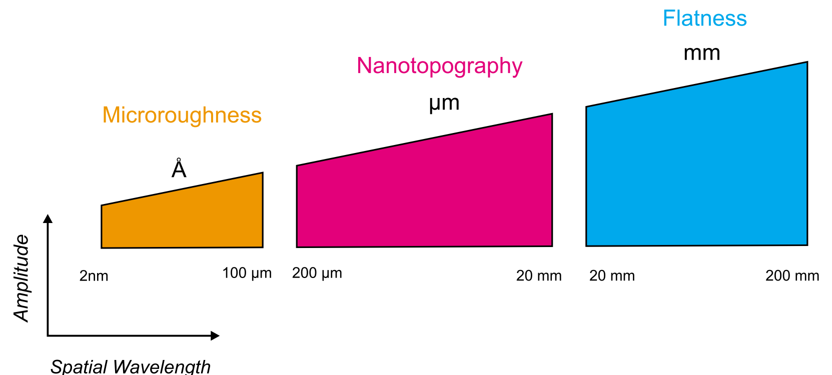

Fig. 1: Three spatial regions of surface mesurement: microroughness, nanotopography, flatness.

Measurement Tools

Several types of measurement tools are offered for nanotopography measurements. Only optical systems offer the complete spatial wavelength band and vertical height capability required for nanotopography. Several optical tools are available for this measurement. Some tools quote the ability to measure the full wafer at every site. However, these measurement tools are generally expensive. An alternate measurement system offers nanotopography with excellent vertical height resolution. This measurement tool, from Chapman Instruments, offers 2D line scans at selected locations. The measurement geometry can be pre-programmed to include any specific location on 200 mm or 300 mm wafers. The new Chapman MP2300 offers complete nanotopography measurements with the addition of two new key features. The first new feature is a patented automatic notch or flat finder – with capability much finer than a pre-aligner. This allows accurate positioning of the wafer before the measurement. The second new feature is pattern recognition. This feature allows nanotopography measurements on patterned wafers. The system can be used to identify specific locations for measurement and provide nanotopography measurements on either bare Silicon or patterned wafers.

Measurement Examples

One measurement example is shown in Figure 2 from a polished silicon wafer. This wafer was selected as a representative example of several complete system

175 Research Blvd.
Rochester, NY 14623
USA
800-876-9125
716-424-1380–Phone
716-424-2142–Fax
www.chapinst.com
sales@chapinst.com
support@chapinst.com

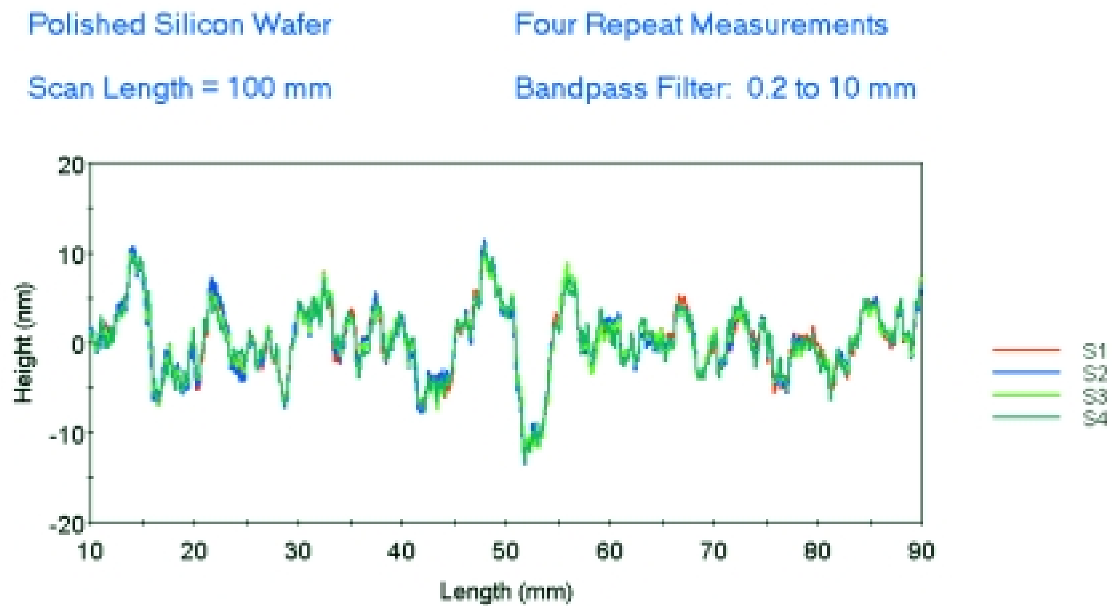

Fig. 2: Four repeat scans of a silicon wafer.

tests performed on the Chapman MP2300 system. The result shown in Figure 2 shows a repeat test at the same location of a polished 200 mm wafer. The overall repeatability shown is good, demonstrating the usefulness of the Chapman system for discrete nanotopography measurements

Conclusion

An examination of local site flatness defined as nanotopography can be measured on either bare Silicon, or pattered wafers. The Chapman MP2300 provides excellent measurement capability at any location of 200 mm or 300 mm wafers.