CytoViva®

Silicon Wafer Doping Detection (Reflected Light Darkfield Hyperspectral Imaging)

A semiconductor wafer is made by permeating a purified silicon matrix with ionic elemental compounds, a process know as doping. The most pressing need for identifying doping levels is to protect against malicious manufacturing of wafers. Malicious manufacturing of wafers may cause early chip failure that can lead to a full system failure once the wafer has been integrated into a working system. Identifying the doping levels of these wafers is important in military applications when semiconductor wafers are purchased from a foreign source. The CytoViva Hyperspectral Imaging System technology can be used to identify and characterize elemental doping levels in manufactured silicon wafers.
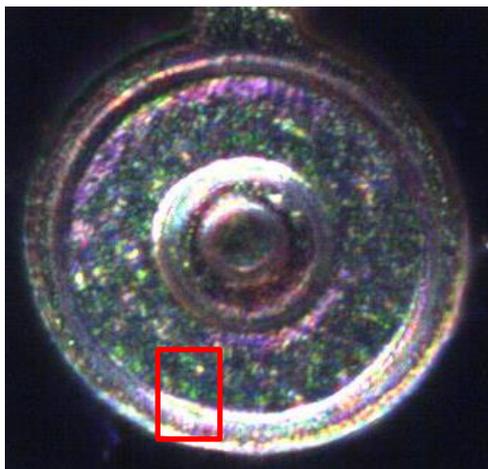

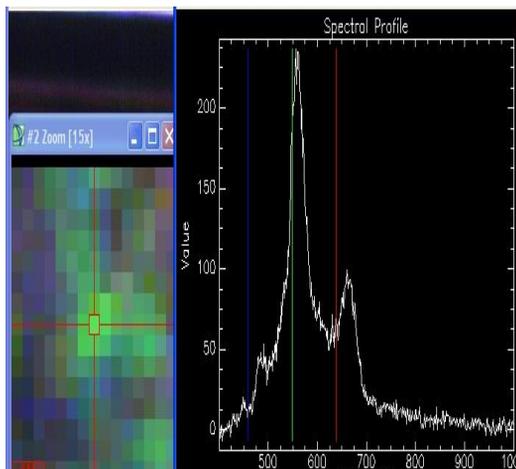**Figure 1**: Memory well on silicon wafer

Figure 2: Single pixel spectral signature

Figure 1 shows a CytoViva hyperspectral scan of a memory well on a silicon wafer. The colors present in this image are indicative of different elements in the silicon matrix. Using the CytoViva Hyperspectral Imaging system gives the ability to select a single pixel (or region of interest) and see the spectral signature of this specific area. Figure 2 shows the spectral signature of this single pixel doping area. The magnified window is from the section ringed in red in Figure 1.
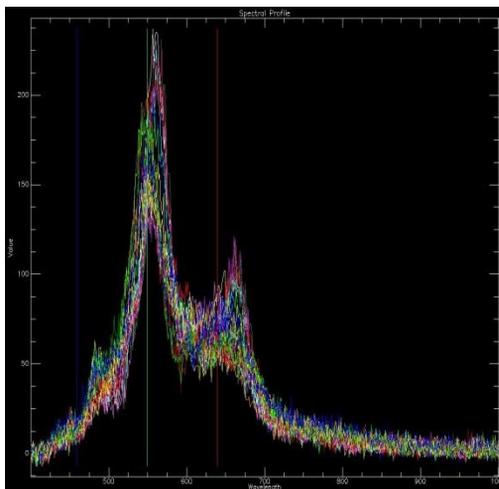

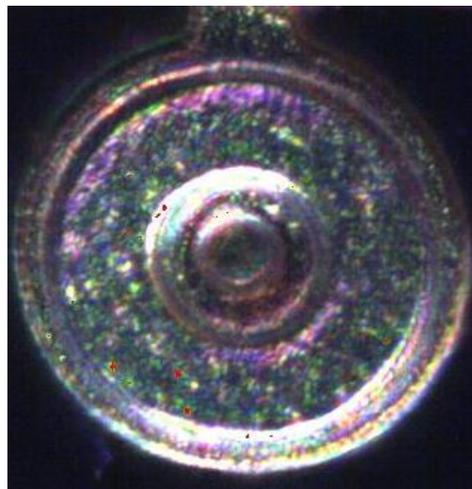**Figure 3**: Spectral library of "green" pixels

Figure 4: Red confirms presence of "green" element in sample

The imaging system can also identify multiple layers within the wafer. Targeted spectral libraries can be used to isolate specific elemental doping within a layer. Spectral libraries are created using the Hyperspectral Image Analysis Software. The sample library seen Figure 3 is a representation of the "green" element embedded in the silicon and was used to detect other areas of similar doping. The red pixels in Figure 4 show the presence of all the "green" element in this field of view. This technique can be used for defensive detection or for quality control in a manufacturing environment.