Automated Semiconductor Wafer Visual Inspection And Defect Review

Using Motion Control and Image Analysis Software Integrated With Prior ProScan-3 XY Motorized Stage and ProZ Stand to Create a High Performance Inspection System.

Introduction:

As semiconductor wafers (substrates) become larger in physical size, semiconductor circuits (patterns) printed on those substrates continues to shrink. Patterned wafer defect inspection has evolved from a manual operation to a fully automated process. Automated wafer inspection equipment was primarily being utilized in engineering environments, but advances in inspection technology, along with the well documented yield improvements realized with automation, now allow for automated wafer inspection to become a more integral part of the production manufacturing strategy.

In the application described below, an optical inspection system is used in conjunction with a Prior ProScan motorized XY stage, ProZ motorized column, theta (rotation) wafer chuck, and controller, in order to facilitate inspection of the wafer surface.

Specifically, the following hardware and software was used:

Equipment:

- Prior ZC12 ProZ motorized column with mount for microscope optics
- Prior H116 motorized & programmable XY stage with linear encoders
- Prior HWCV motorized wafer rotation chuck with vacuum hold down
- Prior H31XYZEF ProScan III Controller
- Prior PS3J100 XYZ joystick control
- MIS PaxCam high resolution digital camera
- MIS Pax-it! Imaging and motion control software package
- Olympus UIS BF/DF optics with motorized objective turret and auto focus
- Desktop PC running Windows 7 and large format color flat panel monitor

ProScan Controller Programming:

No special programming of the ProScan was required. Utilizing the standard SDK provided by Prior, the software developer (MIS in this case) was able to control all hardware to complete automated tasks associated with inspection.

Application:

Wafer inspection typically relies on a human operator to look through a microscope in hopes of locating defects on the wafer surface, or in the printed patterns. This task can be tedious and creates ergonomic issues for the operator, along with growing margins for error as operator fatigue sets in. With the semi-automated system as shown below, an operator only has to place a wafer on the stage and press a few buttons. The defect review and motion control software will then initialize two critical alignment functions; 1. Alignment of the wafer to assure proper orientation of the wafer in X, Y, & Ø. This is important for both creating the initial map of inspection sites and for future review of the mapped sites. 2. Mapping of the objective lens parcentration, which allows for offsets to be saved, and will compensate for any mechanical issues associated with the microscope hardware.

After the initial alignment sequences, the system will automatically move from programmed site to the next, with sub-micron accuracy, for inspection. An operator need not be present while the system runs, if automatic image capture, and/or 'golden part comparison' has been initiated. Alternately, an operator can observe the operation and interrupt the scan to save a particular field-of-view as a site of concern, if required. Digital images can be captured during these scans as well, and can be revisited with the saved X, Y, theta location information which has automatically been stored for each image. Once the inspection process is complete for that wafer, the operator removes the sample from the stage and repeats the process as required. Other functions, such as detailed image analysis or critical dimension (CD) measurement, can be performed as well. Using this platform as a building block, and adding components such as automated wafer loading to the microscope stage, creates a modular system which can be utilized in a variety of inspection steps.

Summary:

By using the ProZ column and other Prior motorized components, integrated with powerful image analysis and high quality optics, semi or fully automated wafer inspection can be achieved to meet the goals of wafer manufacturing, engineering, or failure analysis labs.