

Characterization of Thermo-Photo Voltaic Diodes with Robotic Prober

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Category

Products Used

LabVIEW 7.1
GPIB

The Challenge

The challenge was to improve the use of a pre-existing application which controlled a Micromanipulator 8860 Prober. This Prober is used to perform different measurements on ThermoPhotoVoltaic (TPVs) diodes on a silicon wafer. Through an automated process the operator needed to select a list of devices to be characterized by means of illuminated IV (current vs. voltage) curves. The results of the IV curve acquisition would then be analyzed with the results and IV data stored to a database.

The Solution

Data Science Automation (DSA) was selected to develop software that integrated the control of the probe positioning of the micro manipulator 8860 with an application previously developed by DSA to automate the IV Curve acquisition for TPV diodes and other test structures on a wafer. The software also controls lamp intensity and controls the thermal state of the system. After acquiring the IV curve data, the software performs a set of analysis that characterizes the device to be stored as analysis results. The acquired data and analysis results are stored in a relational database organized by the device information.

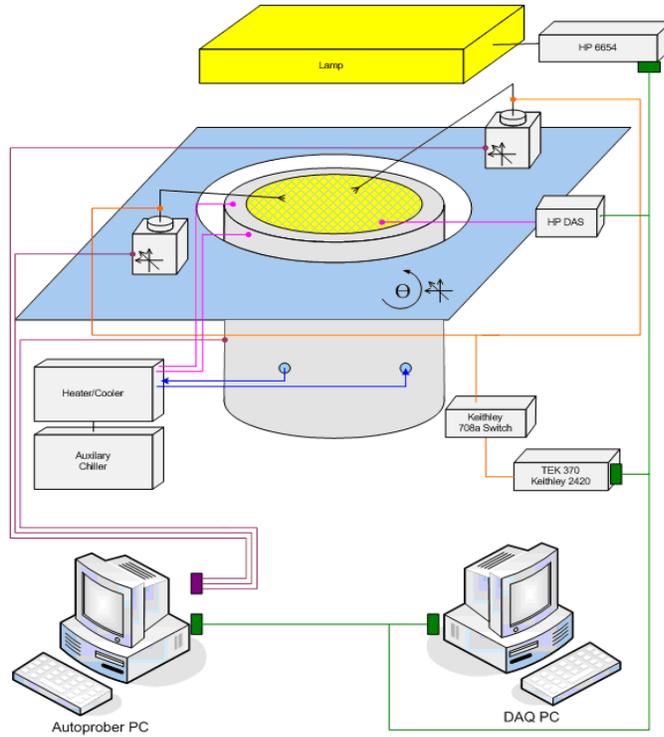


Figure 1. Hardware Setup

The Details

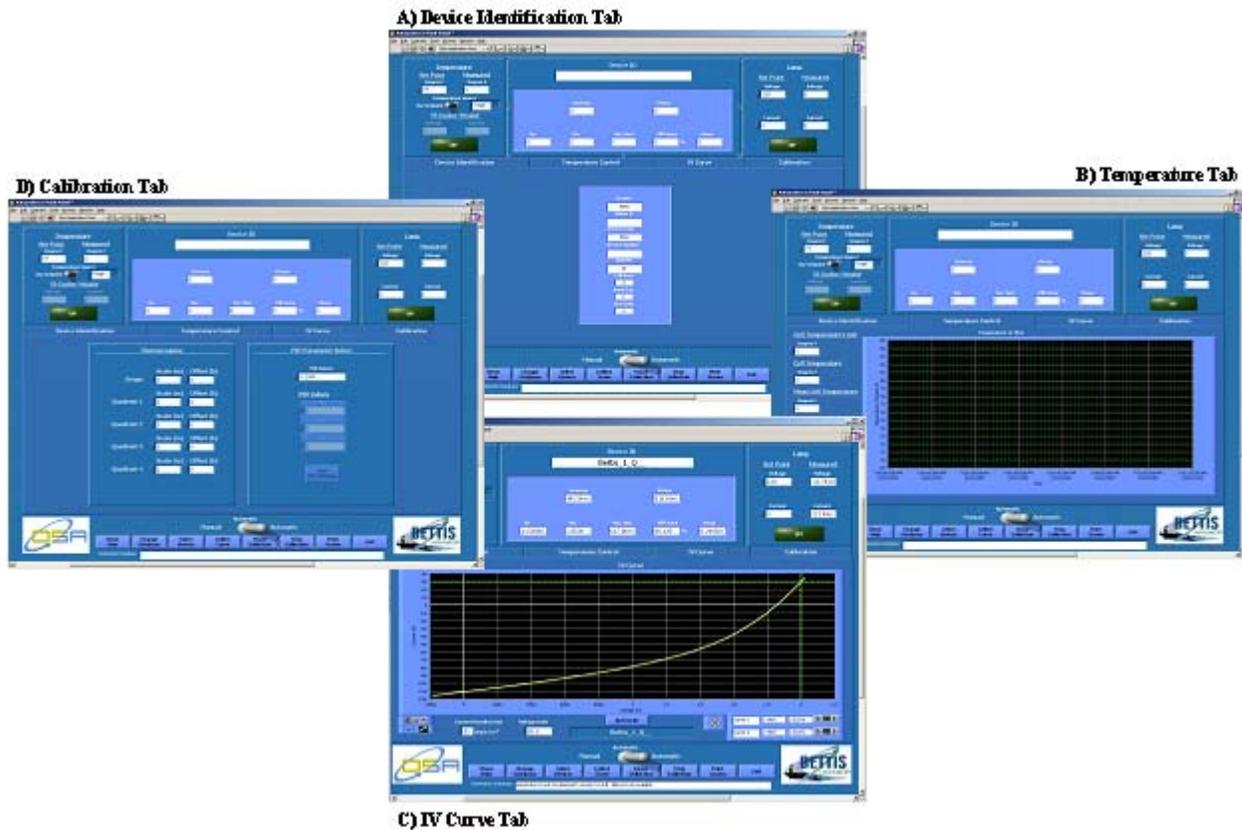


Figure 2. Front Panel Tabs

Using an application previously developed for the client by Data Science Automation as a base, the functionality of the probe movement was added along with the Device Selection process. Communication to numerous instruments is done over GPIB.

The application operates in two modes: manual and automatic. In manual mode the operator sets the lamp current and acquires an IV curve at the click of a button. The IV curve acquired is that of the current position of the probe tips on the wafer. No movement is conducted in manual mode.

In automatic mode the application automatically characterizes a selected subject of devices or the wafer over a range of illumination and temperature conditions sets the selected lamp currents and acquires IV curves for a selected list of TPV devices by moving the prober from device to device. The IV Curves are displayed on a graph on the IV Curve tab (Figure C). After the application moves the prober through the complete list of TPV devices it then sets the HP 6645 lamp power supply output to the next lamp current that was chosen and proceeds to acquire IV curves again for the list of TPV devices. This process repeats for all lamp currents specified.

Since each wafer contains multiple device types with varying dimensional characteristics (as related to the necessary probe positions) the dimensional information was pulled from the photo mask design file and placed in a database. The selection of the TPV devices to be tested and lamp currents is performed by clicking the 'Select Devices' button. The operator is presented with a popup (Figure E) in which the device selection process is started by entering the wafer information. This can be entered manually or by scanning the barcode on the wafer curver. Next, a drop down menu of Device Types is populated based on the wafer information entered. This is done through queries to an entity database which stores wafer and device information. After the operator selects a Device Type, a list of Devices is populated from the entity database. The

operator can then specify which devices are to be tested by using checkboxes next to the device ID. Lastly, the operator selects lamps currents from a list displayed on a second popup window.

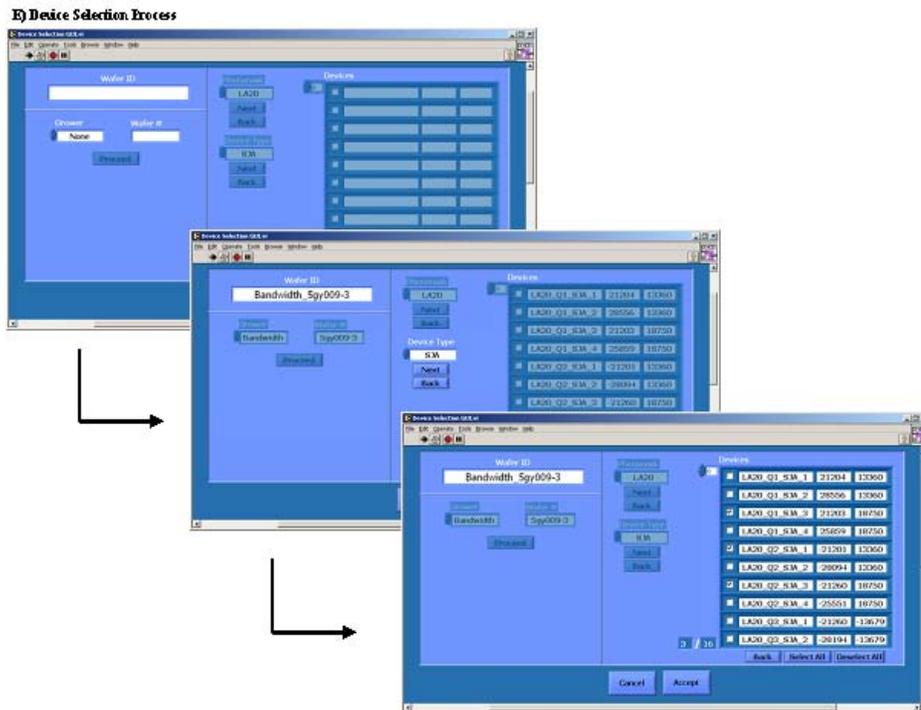


Figure 3. Device Identification

The information for the device that is about to be tested is displayed on the Device Identification tab (Figure 3). It contains Grower (manufacturer of the wafer), Wafer #, Device Type, Device Number, Quarter (of the wafer), Cell Area, Number of Cells, and Band Gap. The Device ID is also shown at the top of the screen.

The IV curve acquisition is done through a Keithley Instruments 2420 SourceMeter. A separate LabVIEW application, developed by Data Science Automation, is used dynamically in conjunction with the main application. It continuously displays IV Curves by having the Keithley 2420 perform voltage sweeps in order to provide the continuous visual feedback that the operators were familiar with from their prior use of the Tektronix 370A curve tracer which has an integrated graphical display much like an oscilloscope. This application also has two modes: manual and screening. Manual mode simply uses the start and stop voltages set by the operator on the Keithley application front panel, while screening mode implements an algorithm that takes a measurement of the Open-Circuit voltage (Voc) and calculates the start and stop voltages to use that will maximize resolution in the region of integration. Device type dimensions are characterized by device center and probe spacing. While running the main application in automatic mode, the Keithley takes a resistance measurement before acquiring a trace to ensure there is electrical continuity between the probe tips and the device. A Keithley 708a Switch Matrix also exists to switch between different measurement types, a CV instrument however currently only IV Curve acquisition is implemented.

The application also monitors the thermal state of the system using thermocouples and a HP 75000 data acquisition system, which allows for future implementation of PID control function that exists in the base application. The Calibration tab (Figure) contains gains and offsets that allow the operator to change for the thermocouples and additional controls (currently disabled) for the PID control.

The control of the Micromanipulator 8860 Prober is rather unique because commands are sent from the main LabView application to a program called pcBridge on the probers control PC. The pcBridge software is supplied by the vendor of the Prober and allows external control of the prober. In order to expedite the development of the application only a subset of the Prober commands were implemented. This requires some manual setup of the prober before running the home positions and axis alignment. The sequence of commands which are sent for movement from device to device are the following: (1) Raise probes tips off of device, (2) Set probe spacing for device type, (3) Move probes to center coordinate of next device, (4) Lower Probe tips to contact device and establish thermal equilibrium. The application will then acquire IV curve as described above, analyze and display the results, log results to database file

Summary

Using LabVIEW, automation engineers at Data Science Automation were able to productively upgrade a previously developed base LabVIEW application to provide an automated solution for the client that will increase their testing efficiency greatly. The delivered product, and the service that accompanied the product, exceeded the expectations of the client by providing an effective solution under a tightly constrained timetable and also providing a solution that has flexibility to adapt to the changing needs of the client. Now with only 5 minutes of operator setup time tens of devices can be tested without any operator intervention saving hours of operator attention. The base application was subsequently upgraded again to replace a second HPVVEE application and a new test stand that characterizes arrays of interconnected TPV devices.