RUDOLPH TECHNOLOGIES

SMART MANUFACTURING SOFTWARE

WEAVING DIGITAL THREADS INTO A GLOBAL FABRIC OF ENTERPRISE KNOWLEDGE

Detailed genealogy provides die-level knowledge across the supply chain to drive yield learning throughout the process from bare wafer to final module test

DISCOVER® DEFECT SOFTWARE

Discover Defect software collects data from the manufacturing process into a single, monolithic database that integrates vital product parameter data from every die at each step in the process with performance and condition data from all tools, factories and providers in the supply chain. It provides unprecedented visibility – sensor deep and value chain wide – of the entire manufacturing process from design, through wafer fab, test, assembly and packaging. The use of a single database means that data are available for immediate analysis rather than having first to be located and aligned from disparate databases at multiple facilities. Specialized algorithms, developed over years of experience solving yield issues and designed for big-data operations, find hidden correlations among parameters, events and conditions that can quickly guide engineers to the root causes of yield losses, ultimately delivering higher process yields and more reliable products.

KEY BENEFITS

One of the key benefits of Discover Defect software is its ability to quickly provide a detailed genealogy of every die, which expands basic traceability to deliver access to all of the information available from sensors on the tool (temperature or pressure), process events (lot-to-lot changes), equipment events (alarms or preventive maintenance), changes in process configurations (specifications or recipes), and any other event or condition captured in the database. Discover Defect software is designed to find those correlations and those devices quickly and easily.

CASE #1

CUSTOMER CHALLENGE

This customer is a leading global supplier of electronic systems to the automotive market. Its products typically contain multiple ICs manufactured by various suppliers and facilities. Unequivocal reliability and part error rates at parts-per-billion levels is an absolute requirement because the health and safety of millions of drivers may be jeopardized by a defective product. Limiting these risks, and the associated financial liability, through fast root-cause analysis of in-house test failures, field returns and rapid identification of process drift or step function changes is a critical need. Tuning the process to improve yields while preserving critical reliability is equally important to the customer's bottom line.

THE RUDOLPH SOLUTION

The final product is a multi-chip module containing microelectromechanical system (MEMS)-based sensors and application-specific integrated circuits (ASIC). These component parts were functionally tested individually prior to being selected for module assembly. Each of the parts are attached to a common carrier to form a sealed module and then retested to verify functionality of the completed assembly (shown schematically in Figure 1).

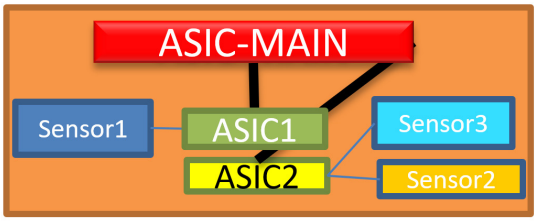

FIGURE 1 *The customer product contains multiple sensors and processors, each on a separate die.*

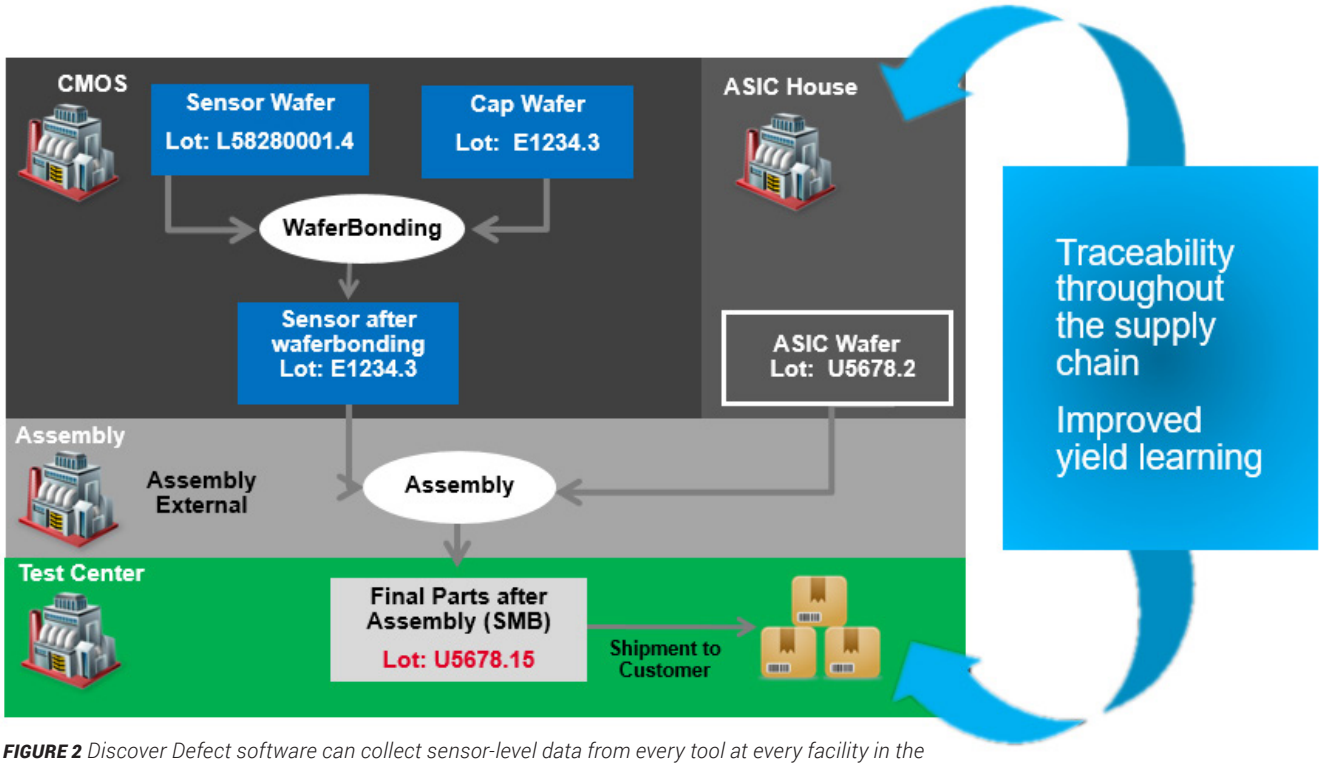

FIGURE 2 *Discover Defect software can collect sensor-level data from every tool at every facility in the value chain.*

Discover Defect software collects data across the entire supply chain (Figure 2). In this case, the sensors come from one fab while the ASICs come from another. Both go to an assembly facility for packaging then to a test center for final test and shipment to the customer.

Devices from a single wafer fab lot are ultimately split and mixed among many finished modules and assembled over time. Figure 3 shows a commonality plot that illustrates the separation of wafer lots into multiple assembly/test lots through the process. Using this kind of analysis, engineers can quickly identify die that share a similar risk and track them to their ultimate dispositions in finished modules. The tracking is not limited to wafer level. For instance, it might be used to find only those die located on the straight-line extension of a known crack or within at-risk regions identified by statistical pattern recognition (SPR).

BENEFITS EXAMPLE

Based on the findings illustrated in figure 3, this customer saw that all effected modules were assembled within a short time period of one another. Further investigation found that the packaging process was affecting peak-to-peak voltage at final test. Known-good-die at wafer probe were failing final test in the module package. The customer was not able to modify the assembly process, but they were able to eliminate the final test losses by tuning wafer probe specifications to eliminate die potentially damaged in the assembly operation. A key to achieving this solution was the ability to quickly and easily compare data sets on the same dies from wafer probe and final test. Without Discover Defect software, they lost die-level traceability when the wafer was diced.

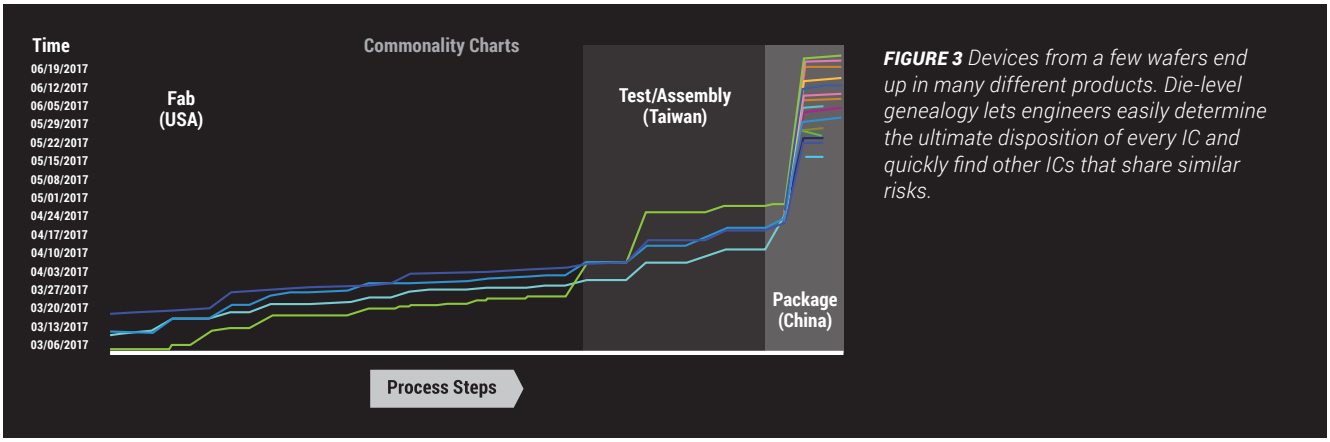

FIGURE 3 *Devices from a few wafers end up in many different products. Die-level genealogy lets engineers easily determine the ultimate disposition of every IC and quickly find other ICs that share similar risks.*

CASE #2

CUSTOMER CHALLENGE

The customer is a global supplier of advanced mobile communication devices. Final modules must integrate data processing, data storage, RF communications, power management, analog sensing, and other functions, as well as contain die and components fabricated at various facilities around the world. At one point in the process, individual surface acoustic wave (SAW) and bulk acoustic wave (BAW) filters from different wafers are combined on a single substrate (panel). Figure 4 graphically shows BAW and SAW die coming together in assembly and illustrates to the user the parametric distributions of both the components and the assembled panel. and rapid identification of process drift or step function changes is a critical need. Tuning the process to improve yields while preserving critical reliability is equally important to the customer's bottom line.

BENEFITS EXAMPLE

This customer did not have traceability once the die was separated from the wafer. Discover Defect Software provides die-level traceability throughout the multi-site process. With this feature, the manufacturer was able to determine not only the original wafer, but the location on the wafer, allowing final test data to be related to location-specific information from inspection, metrology and test procedures during fabrication, such as defect patterns or dimensional variability uncovered by advanced statistical analysis.

In this case, the customer gained additional insights surrounding the origin of the die being assembled and was able to evaluate how shifts in performance parameters of the BAW and SAW parts impacted the final module product. This resulted in better matching of parts in the pre-assembly process and a tighter distribution of performance parameter in the outgoing modules.

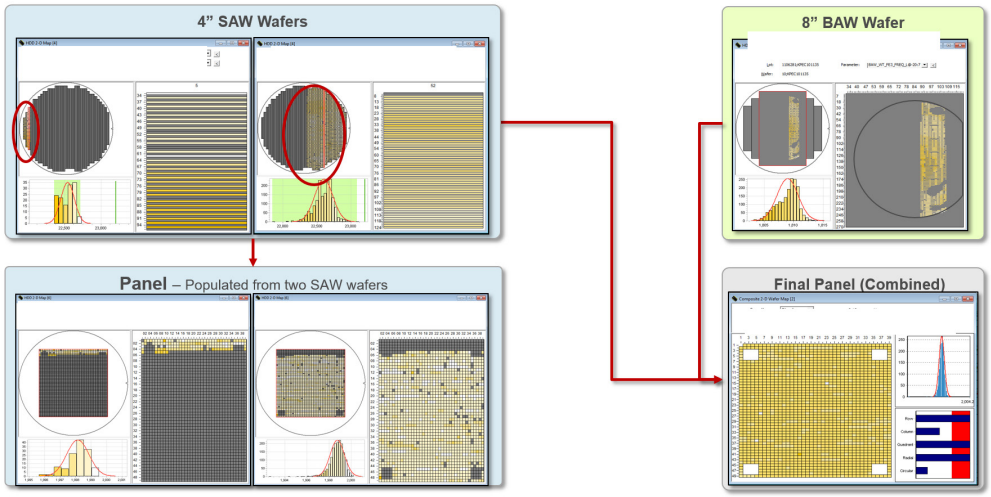

FIGURE 4 *A single panel contains SAW and BAW filters from multiple wafers. Discover Enterprise provides die-level traceability, allowing engineers to relate final test results to inspection and metrology data collected during wafer processing. Die can be traced back to their individual location on the original wafer, permitting associations with location-specific data such as defect patterns discovered by SPR*