Wafer/Panel Level Fine Pitch Substrate Inspection/Metrology Project, Phase 3

Call for Participation Webinar
March 5, 2020

Project Leaders:
Feng Xue – IBM
Joe Zou Zhihua – Intel
Charles Reynolds – IBM
iNEMI Staff: M. Tsuriya
Agenda

• Introduction of Project Chairs and Facilitators
• iNEMI Project Development Process
• Project Briefing
  – Background & Objectives
  – Project Scope
    • Project IS/IS Not
  – Timeline
• How to Join
• Q&A

Note: All phones will be on mute until the end of the presentation
Introduction of Project Chairs & Facilitators

Project Leader: Feng Xue
IBM

Joe Jou Zhihua
Intel

Co Leader: Charlie Reynolds
IBM

iNEMI Staff: M. Tsuriya
iNEMI Project Development Process - 5 Steps

0. INPUT

1. SELECTION

2. DEFINITION

3. PLANNING
   - "Initiative" Open for Industry input
   - iNEMI Technical Committee (TC) Approval Required for Execution

4. EXECUTION / REVIEW
   - "Project" Limited to committed Members

5. CLOSURE
Project Briefing
Background

- Heterogeneous SiP packages are becoming popular as an electronic packaging solution. In addition, circuit boards are also incorporating high-dense circuit patches and layers to support increase signal requirements. These packages require finer circuitry patterns designs. However, it is difficult to validate the designed line width and spaces to be measured, and to detect the defect features.

- Inspection limitations are likely to impact yield assessment and quality validation on the substrate/interposers which will be used for heterogeneous SiP packages.

- Measurement capability on fine line (<10um) and space (<10um) on the panel size substrates/interposer impacts both yield and performance capability. Fine line and space requirements provide high density interconnects which supports the advanced package technologies for multiple components integration.

- iNEMI started the project Fine Pitch Circuit Pattern Inspection Metrology in 2016. In Phase 1 of the project, the team conducted an industry-wide survey to assess the readiness of measurement and inspection capability for fine circuit pattern substrates. The survey was completed in February 2017.

- The team continued to Phase 2, in which an inspection capability study on a glass based test vehicle and a silicon wafer based test vehicle was conducted. The test vehicles (TV) were designed with fine pitch pattern trace widths from 10um nominal down to 1um nominal, and associated defect design such as excess copper and missing copper. The sizes of these defects’ sizes are varied from 10, 30, 40, 60, 80% from the nominal values. The phase 2 project was completed in February 2020.

- The team agrees to continue the work an organic substrate as a test vehicle since current heterogenous SiP substrate and interposers are mainly used with organic substrate. A similar test vehicle design used in Phase 2 will be used for fabricating an organic substrate TV for inspection and measurement capability study in Phase 3.
The Purpose of Project

- This project is a continuation from Phase 2. The purpose of this project is to further characterize and quantify optical inspection equipment capability by conducting inspection capability study and analysis using an organic panel test vehicle.
  - There is greater impact in organic substrate and board yield due to defects from fine-featured line width and spacing violations as well as foreign material.
  - The Phase 3 organic test vehicle is designed with known defective fine-featured wiring to comprehensively examine AOI capability to handle differences in organic material properties such as color, reflectivity, and surface roughness as well as substrate warpage and shape deformation.

- Validate the design rule of organic substrate fabrication using the same design rules used in phase 2.
  - A defect pattern design with 6 different line widths is fabricated in panel form to create the Test Vehicle.
  - Defect patterns include a) Line width violations, b) Spacing violations and c) Excess copper or missing.
  - Line widths are designed with 10um, 8um, 6um, 4um, 2um, 1um. These line widths might be changed due to fabrication techniques.

- Test vehicle of organic panel was fabricated as panel (250mmx 250mm size)
- Measure the line width and inspect the defects per the designated location.
- Collect data and analyze the inspection data.
Trace Width Measurement Guideline
For AOI Partners

6 Nominal Width Design in a Cell

7 Measurement Location in one Width Design
The metrology TV will be diced from the panel. The size of the TV will be decided by project team prior to dicing.
Task 0 – Kick-off phase 3 project by forming the project team
Task 1 – Fabricate Organic panel TV (2 months)
Task 2 – Verify the dimensions of retuned organic unit cells by SEM and CMM (2 months)
Task 3 – Inspection & Measurement of Organic Test Vehicles. (5 months)
   Resources:
   o In-kind contribution for the inspection/measurement services
Materials and Processes:
   o Follow the measurement/inspection guide for all sites
   o Measure inspection accuracy and efficiency in terms of defect rate and inspection capability with fine lines and space designs
   o Inspection report will be submitted to the project manager which contains line width for all designated location and traces and the defects images with the recess rate from the line width.
   o The inspection site will bear the incurred cost in their country/site and will bear the shipping cost when the TVs will be shipped back to IBM.
Task 4 – Summarize and analyze the data (3 months)
Task 5 – Publish the project summary report and conduct the webinar (2 months)
**IS / IS NOT Analysis**

<table>
<thead>
<tr>
<th>This Project IS:</th>
<th>This Project IS NOT:</th>
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<tbody>
<tr>
<td><strong>Phase 3</strong></td>
<td></td>
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<tr>
<td>Evaluate defects at intermediate level (in build at organic laminate material)</td>
<td>Develop new inspection and measuring equipment machine/systems</td>
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<td>Review the measurement capabilities by different equipment and test vehicle.</td>
<td>Conduct the qualification efforts on specific metrologies at a specific company</td>
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<tr>
<td>Provide the technology readiness statement for fine pattern inspection on substrates and circuit boards</td>
<td>Develop a specific standard(s)</td>
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<tr>
<td>Create recommendation for the metrology</td>
<td>Repeat prior or existing work</td>
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<td>Biased towards specific suppliers, geographies, or market segments</td>
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<td>Involve any devices/assembly process and not involve any reliability test</td>
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Outcome of Project

- List issues that are expected to be addressed and/or resolved, e.g., identify gaps, report(s) on results of any testing, etc.
- Inspection results are shared among the project members, which include the metrology options, technical gaps and technical plans on the metrology and inspection systems.
- Comparison and assessment of the inspection results, and recommendations are provided for the metrology option in selection.
- A summary report is available to all iNEMI members in reports from this project.
How to Join
iNEMI Project Management Policy

• Two governing documents for projects
  – SOW (statement of work): sets out project scope, background, purpose, benefits, and outlines required resources, materials, processes, project schedule, etc.
  – Project Statement (PS): signed by participating companies to secure commitment on resource and time contributions.

• iNEMI Project requires iNEMI membership
  – Signed membership agreement
  – Commitment to follow iNEMI By-laws and IP policy
Sign-Up Due on March 19, 2020

- iNEMI membership is required to join the project
- Download SOW and PS from iNEMI web:
  https://community.inemi.org/content.asp?admin=Y&contentid=643
- Process to participate this project:
  - Sign the PS
  - Send scanned PS to infohelp@inemi.org
  - iNEMI VP of Operations will approve your participation and send you back the completed PS with acceptance
- Join iNEMI membership, or questions, contact M. Tsuriya (m.tsuriya@inemi.org)
Path to Kick-off Meeting

• Call for Participation Webinar: March 6, 2020
• Sign-up Due: by March 19, 2020
• Kick-off Meeting:
  March 27, 2020 from 10:00AM Japan time
  (March 20, 2020 from 10:00AM Japan time for the chairs’ meeting)

Note:
Meeting time might be changed due to the participants’ preference and availability
Questions?

Project web page: https://community.inemi.org/content.asp?admin=Y&contentid=643