ULA (Ultra Low Alpha)

Dedicated Line for

FC BGA

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➤ Low Alpha Particle Control Strategy

➤ Raw Material Management

➤ Design / Layout Confirmation

➤ Dedicate Line for Assembly

➤ Summary
Introduction - Soft Error

- Soft Error / SER (Soft Error Rate)
  a. High energy particle creates electron-hole pairs in the silicon.
  b. Charges drift and collect at nodes, producing a prompt current.
  c. Charges diffuse toward the nodes, producing lower current.
  d. When current accumulated large enough, memory states is switched.
  e. High chip density, smaller device dimensions & lower voltage increase the susceptibility of memory devices to soft error.

(SoC, SRAM, DRAM,...)

Introduction - Solution for Soft Error

- Three conditions to cause soft errors:
  - Present within 50 \text{um} of the device surface
  - With a \textit{direct line of travel} to the device surface
  - Number of electrons storage well exceed critical charge

\text{Source: IEEE Transaction on Reliability, Soft Errors Induced by Alpha Particle (1996)}

- To eliminate the alpha particles:
  - \textit{Less susceptible design} (Move source away from devices).
  - \textit{Add shielding} (Die coatings or polyimide thin film)
  - \textit{Packaging materials} (Using low / ultra low alpha particle)

Low Alpha Particle

Control Strategy
Low Alpha Particle Control - Scope

Material been monitored:

1. Molding Compound/ Liquid Encapsulant
2. Solder Paste.
3. Flip Chip Underfill.
4. Epoxy/ Epoxy Film (for STK PKG)
5. Substrate Pre-solder.

New Device:
Define Control Level in PDM. after aligning with Customers.

Old Device:
No Action. unless have any Special instruction.

Material alpha particle control level criterion (unit: count/hour-cm²)

- Normal: 0.05 (cph/cm²)
- Low Alpha: 0.002 (cph/cm²)
- Ultra Low Alpha:
Low Alpha Particle Control - Mechanism

- **PID (Product)**
  - Item Header: Alpha Level
  - BOM
  - Routing
  - Package Info
  - Drawing
  - MFG ID

- **MTL ID (PUR Spec)**
  - Item Header: Alpha Level
  - Substrate Pre-solder
  - Solder Paste
  - Molding Compound
  - Liquid Encapsulant
  - Underfill
  - Epoxy / Film

**Notes:**
- ULA
- LA
## Low Alpha Particle Control - Working Plan

<table>
<thead>
<tr>
<th>Work Item</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Organization</strong></td>
<td></td>
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</tr>
<tr>
<td>A.1 Teaming Up (CDE/CPE/MPE/QA/Pricing/PUR/MM/IQA/MFG/MIS)</td>
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<tr>
<td>A.2 Role &amp; Responsibility, KPI Definitions</td>
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<tr>
<td><strong>B. Basic Data Preparation</strong></td>
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<tr>
<td>B.1 Material PUR Spec Buildup for Alpha Ray control Level</td>
<td></td>
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<tr>
<td>B.2 Vendor Inspection Report Collection &amp; Buyoff</td>
<td></td>
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<tr>
<td><strong>C. IT System Development</strong></td>
<td></td>
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<tr>
<td>C.1 New Data Item &amp; Checking Logic Coding</td>
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<tr>
<td>C.2 Table Creation &amp; Data Migration</td>
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<td><strong>D. Engineering Preparation</strong></td>
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<tr>
<td>D.1 Training &amp; Certification for ASE Alpha Control Policy</td>
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<tr>
<td>D.2 APQP, AMQP, RA, Design Flow Modification</td>
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<td></td>
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<tr>
<td><strong>E. Manufacture Preparation</strong></td>
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<td></td>
</tr>
<tr>
<td>E.1 Management &amp; Containment of Radioactive Contaminants</td>
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<td></td>
</tr>
<tr>
<td>E.2 Training &amp; Certification for ASE Alpha Control Policy</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Raw Material Management
Raw Material Management - by package

- **Wire Bond (L/F & BGA) Package**
  - Molding Compound / Liquid Encapsulant
  - Epoxy / Epoxy Film (for STK PKG)

- **Flip Chip package**
  - Solder Paste for chipcap
  - Underfill
  - Substrate (pre-solder) for FC bond.
  - Molding Compound (for MFC PKG)
  - Epoxy / Epoxy Film (for STK PKG)

- **WLP package**
  - Solder Paste for printing
  - *Anode / Plating solvent for plating
Raw Material Management - Mechanism

Vendor selection

New Assembly Material Qualification

Vendor Change control

Incoming Material Qualification Flow

Incoming inspection procedure

Incoming inspection items are ULA/ LA label, CoC review and 3rd test report.

Incoming Material Qualification Flow

Monthly quality Meeting

Supplier rating and ranking

Supplier surveillance audit

VCAR flow

NCMR flow
Raw Material Management - measurement capability

Measurement Capability set up:

In-house or certified third Party for ULA monitoring

Co-work with Third party to set up ULA measuring capability:

* Equipment Survey:

* Test Method Survey:

* Certification Standardization:
Raw Material Management - PID release system

Step 1: Input MTL P/N (PUR Spec) α Level.
Step 2: Provide Engineer RA result & BOM.
Step 3: Input Product Device α Level.
Step 4: BOM data maintenance.
Step 5: Confirm BOM align Device’s α Level
Step 6: Issue travel card ID with α Level for production
Drawing / Design Layout

Confirmation
Package Certification

Drawing /Design Layout

Design Request

Design Information confirm

Substrate Design

Design Questionnaire (Information Confirm)

Design Checklist (Add alpha particle)

Design Approval & Substrate Order

Customer approval (customer Confirmation)

Substrate Manufacturing

Checking mechanism on each design stage

Substrate Incoming Inspection
### Package Certification

#### Design Questionnaire
- Add alpha particle request item.

#### Drawing / Design Layout

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Die Bump number</td>
<td></td>
</tr>
<tr>
<td>Die Bumping Pads Pitch (min.)</td>
<td>mm</td>
</tr>
<tr>
<td>Die Pad coordinate direction</td>
<td>□ Die face up, □ Die face down.</td>
</tr>
<tr>
<td>Die Bump Composition (snipb):</td>
<td>□ 63/37, □ 59/59, □ 10/90, □ RoHS_Sn_Ag_Cu, □ Other</td>
</tr>
<tr>
<td>Die bump alpha (a) spec</td>
<td>□ Low alpha: &lt; 0.02 cph/cm², □ Ultra low alpha: &lt; 0.002 cph/cm²</td>
</tr>
<tr>
<td>Bumping UBM diameter:</td>
<td>mm</td>
</tr>
</tbody>
</table>
# Package Certification

## Drawing / Design Layout

<table>
<thead>
<tr>
<th>Modify</th>
<th>Design Project #</th>
<th>Description</th>
<th>Design Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Add alpha particle information</td>
</tr>
</tbody>
</table>

### Drawing / Design Layout

<table>
<thead>
<tr>
<th>Package type:</th>
<th>Device name:</th>
<th>Substrate thickness:</th>
<th>Substrate layers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>L/C:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package code:</td>
<td>Ball size:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ball pitch:</td>
<td>Chip size:</td>
<td>Substrate type:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>RoHS</td>
</tr>
<tr>
<td>Bump pitch:</td>
<td>UBM dim:</td>
<td>Bump composition:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bump face:</td>
<td>Bump pad type:</td>
<td>Presolder:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>Y (EU or LF)</td>
</tr>
<tr>
<td>Metal finish:</td>
<td>Heat spreader:</td>
<td>(Optional) particle specification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Special requirement:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Double side presolder
- Immersion Tin
- Plated Tin
- OSP
- ENIG

- None
- Thermal lid + Ring
- Stiffener ring only
- HAT
- Cavity
- Thermal lid only
- Other

- SMD Request
- Y
- N
- X-Section
- Wafer cut
## Package Certification

### Drawing /Design Layout

- ULA substrate has different layout drawing #.
- ULA substrate requirement is specified in layout drawing.

<table>
<thead>
<tr>
<th>Description</th>
<th>Material</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished Thickness</td>
<td>63Sn/37Pb</td>
<td>1200 +/- 150</td>
</tr>
<tr>
<td>Pre-Solder</td>
<td>Ultra Low Alpha: ≤ 0.002 cph/cm²</td>
<td>(*A) C4 Pad</td>
</tr>
<tr>
<td>Metal Finish</td>
<td>Immersion Tin</td>
<td>1.0 MIN.</td>
</tr>
</tbody>
</table>
Package Certification

ULA Product Confirmation

RA (Risk Assessment): Product Engineer will check ULA information

- To see if any Embedded memory designed inside chip/package
- To Check what is the ULA Alpha particle level requirement
Dedicated Line for FC BGA Assembly
Dedicate Line Certification

Dedicate Line Set up:

- Dedicated Area: Machine setup & fine tune.
- Dedicated OP: Training and Certificated.
Dedicate Line Certification

Dedicate Machine for ULA Control.

Wafer Grind / Wafer Mount / Wafer Saw

2nd Optical Gate

Pre-solder Substrate Baking

Solder paste Printing

Chipcap Mount

Flux Jetting

Flip Chip Bond / bump reflow

3rd Optical Gate
Dedicate Line Certification

Dedicate Machine for ULA Control.

- Substrate Baking
- Plasma Clean
- Underfill Dispensing/Curing
- Heat Slug Attach & curing
- Marking
- Ball Mount /reflow / flux clean
- Final Visual Inspection
Dedicate Line Certification

MES System:

Only Certified **ULA Operator** to handle ULA products
Only **ULA material** been used in ULA products
Only **ULA machine** can process ULA products.

Bar code Control

Operator Confirmation

Material Confirmation

Machine Confirmation
Summary

1. A dedicated FC line with completed control mechanism:
   - ULA requirement identification,
   - Packaging design procedure control
   - Raw material control,
   - In line process control,
   - Production certification.

2. WB product has validated existing control mechanism:
   - Prevent the alpha particle contamination.
Thank you

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