WS-446HF Flux

Introduction
WS-446HF Flux is a robust, halogen-free, water-wash flux that was designed to provide one simple solution to complicated applications, especially those with a single cleaning step for both BGA ball-attach and flip-chip processes. It has a powerful activator system to promote good wetting on even the most demanding substrate metalizations such as Cu OSP, ENEPIG, and ENIG. Its rheology is suitable for dipping flip-chip applications, as well as pin transfer or printing BGA ball-attach applications, for sphere sizes 0.25mm and above. WS-446HF helps to improve production yield by minimizing non-wet-open defects, missing balls, and electrochemical migration (ECM).

Features
- Designed for flip-chip dipping and BGA ball-attach pin transfer/printing applications
- Promotes excellent solderability and wetting on a wide range of surfaces
  - Good results on AuNi and even on oxidized Cu OSP (up to 0.3mm thick OSP)
- Cleans well with room temperature DI water
  - Saves money on water heating
  - Avoids formation of white residue
- Eliminates ECM or dendrite formation caused by residue
- Designed for Pb-free applications
  - Suitable for all high-tin solders
- Halogen-free – per IPC and IEC specifications
- Ensures consistent joint quality by providing consistent dipping, pin transfer, and printing performance over extended periods
- Promotes strong, low-voiding joints
- Minimizes die skew, non-wet-open, and “missing balls”
  - Maintained tackiness during heating results in faster soldering
- Eliminates warpage due to “prefluxing” with lower process costs
- Reflows in air or nitrogen
- Stable at room temperature for up to 1 year
  - Ease of storage and use without crystals or gel balls
  - Ready to use, straight from the jar or cartridge

Cleaning
WS-446HF residue can be cleaned with DI water, or water with an added cleaner. Ideal conditions for spray-cleaning: 25°C (room temperature) to 40°C for >1 minute at 60psi or higher.

Packaging
WS-446HF is available airlessly packaged in 10 and 30cc syringes, and is also available in jars or cartridges, on customer request.

Storage
For maximum shelf life, WS-446HF syringes and cartridges should be stored tip down. Storage temperatures should not exceed 30°C. If using cold storage, WS-446HF should be allowed to stand for at least 4 hours at room temperature before using.

Technical Support
Indium Corporation sets the industry standard in providing rapid response, onsite technical support for our customers worldwide. Indium Corporation’s team of Technical Support Engineers can provide expertise in all aspects of materials science and semiconductor packaging process applications.

Safety Data Sheets
Please refer to the SDS document within the product shipment, or contact our local team to receive a copy.
PRODUCT DATA SHEET

WS-446HF Flux

Flip-Chip Application

**WS-446HF** is intended to be used in an air or nitrogen reflow environment of 50ppm oxygen or less. **WS-446HF** can be used on many surface finishes. **WS-446HF** has been developed to allow tin and tin/silver solder bumps, in both standard bump shapes and as microbumps on copper pillars, to solder well to any quality of substrate metallization. **WS-446HF** also allows poor-quality OSP to be soldered to, without non-wet open solder joints.

**Flip-Chip Flux Dipping Process**

The dipping depth should be adjusted to exact needs. Guidelines are given in the illustration below. The flux reservoir (dip tray) should be cleaned and replenished every shift.

![Dipping Depth](image)

**Properties**

<table>
<thead>
<tr>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Viscosity</td>
<td>21kcp (5 minutes) Brookfield HB DVII+CP @ 5rpm</td>
</tr>
<tr>
<td>Typical Acid Number</td>
<td>93mg KOH/g Titration</td>
</tr>
<tr>
<td>Typical Tack Strength</td>
<td>150gf J-STD-005 (IPC-TM.650: 2.4.44)</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>12 months at 0~30°C Viscosity change/ microscope examination</td>
</tr>
</tbody>
</table>

**Ball-Attach Application**

**WS-446HF**’s special activator package promotes good wetting on the most demanding surfaces such as Cu OSP. Typically, ball-attach for BGA application is the last step in the assembly process as, at this stage, the pads have gone through multiple heat cycles, wash cycles, etc. These pads are therefore heavily oxidized or contaminated, which affects the solderability of the sphere onto the pad. Good wetting performance of the flux is necessary to ensure final strong joints.

**WS-446HF** proves to be a true single-step ball-attach flux to eliminate the preflux process, thus to avoid the costly, wasteful, and warpage-inducing effects.

The “Standard Ball-Attach Process” diagram shows the typical two-step flux processing that is needed to create reliable, ball-to-pad joints from final BGA balling. The prefluxing step can only be eliminated if the flux has sufficient activity to overcome the extent of the oxidation on copper, and create strong solder joints.

**Ball-Attach Process**

<table>
<thead>
<tr>
<th>Step 1: Preflushing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flux Dip</td>
</tr>
<tr>
<td>Pin Transfer</td>
</tr>
<tr>
<td>Reflow</td>
</tr>
<tr>
<td>Cleaning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: BGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flux Dip</td>
</tr>
<tr>
<td>Pin Transfer</td>
</tr>
<tr>
<td>Solder Ball Drop</td>
</tr>
</tbody>
</table>

**Industry Standard Test Results and Classification**

<table>
<thead>
<tr>
<th>Flux Classification</th>
<th>ORH0*</th>
</tr>
</thead>
</table>

Based on the testing required by IPC J-STD-004A.

<table>
<thead>
<tr>
<th>Halogen-free per IEC 61249-2-21, Test Method EN14582</th>
<th>&lt;900ppm Cl</th>
<th>&lt;900ppm Br</th>
<th>&lt;1,500ppm total</th>
</tr>
</thead>
</table>

All information is for reference only.
Not to be used as incoming product specifications.
PRODUCT DATA SHEET

WS-446HF Flux

Proven Flux Rheology Consistency

Viscosity Test Method
- Equipment
  - Brookfield Cone & Plate
  - Model: DV3THBCB
- Parameters
  - Spindle: CP-51
  - Temperature: 25°C
  - Rpm: 10rpm

Tack Test Method
- Equipment
  - Texture technologies TA.XT2
- Parameters
  - Ambient conditions
  - Humidity: 50% ± 3%
  - Room temperature: 21.5°C ± 2°C

Viscosity as a Function of Time

Viscosity Controls

Tack as a Function of Time

Consistent Flux Rheology Over Time

WS-446HF’s consistent viscosity and tack ensure uniform flux volume on all solder joints. This assures consistent joint quality and a consistent process for better control over time.

- Flip-chip application
  - Holds die in place, minimizing die skew and non-wet open defects
- Ball-attach application
  - Holds spheres well to eliminate “missing ball”

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**PRODUCT DATA SHEET**

**WS-446HF Flux**

**Reflow**

**Recommended Profile**

WS-446HF is suitable for air and nitrogen reflow, and can work well in a variety of reflow profiles.

![Reflow Profiles: SAC305](image)

**Increase Joint Strength**

Joint strength is high due to good wetting. From the solderability testing results, the spreading ratio of WS-446HF is excellent even on a heavily oxidized Cu test coupon. This ensures the solder bump or sphere has good wetting even on demanding surfaces.

![Average Spreading Ratio](image)

**Reduce Open Joint**

- Good wetting
- Good tack to hold FC die in place even though there is warpage issue

![Good Wetting](image)

![Reduces Open Joint and HIP](image)

**Solderability Test Method**

- Print flux onto metalized surface
- Place spheres onto flux deposit
- Reflow (air or N₂ [typical])
- Measure reflowed height deposit
- Calculate spreading ratio (wetting)

\[
S_R = \frac{D - H}{D} \times 100 \quad \text{...(16)}
\]

where,  
- \( S_R \): spreading ratio (%)  
- \( H \): height of the spread solder (mm)  
- \( D \): diameter of the solder, when it is assumed to be a sphere (mm)

\[
D = 1.24V^{1/3}
\]

\[
V: \quad \text{mass (g)/density of tested solder}
\]

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Cleaning

**FIB (Focused Ion Beam) and SIMS (Secondary Ion Mass Spectrometry) Analysis on Cu OSP Substrate**

**Cleaning Test**
- **Very mild (forcing) condition**
  - Deionized water
  - Deionized water conductivity ≤1.00μS/cm
  - Zero pressure
  - Flow rate 5cc/minute

**Simplified, Low-Cost Cleaning**
WS-446HF is cleanable with room temperature deionized (DI) water only, eliminating chemical cleaning costs and costs of heating water.

**Eliminate Dendrite**
- Good cleanability with non-conductive residue

WS-446HF Flux

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## WS-446HF Flux

### Heterogeneous Integration & Assembly Materials

#### Thermal Integration Management
- TIM2 / Heat-Spring®
- TIM1

#### Ultra-Small Passives

#### System-in-Package
- Wafer-Level Ball-Attach Flux
- Ultrafine-Pitch Solder Paste

#### Memory and Flip-Chip / 3D Logic
- Wafer Bumping (Bump Fusion) Flux
- Flip-Chip Flux

#### Ball Grid Array
- Ball-Attach Flux

### Recommended Semiconductor Fluxes and Solder Pastes

<table>
<thead>
<tr>
<th>Material Group</th>
<th>Material Type</th>
<th>Material Name</th>
<th>Flux Type</th>
<th>Halogen-Free</th>
<th>Application</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLUX</td>
<td>Wafer Bumping Flux</td>
<td>SC-5R</td>
<td>Solvent-clean</td>
<td>Yes</td>
<td>Spin coating</td>
<td>High Pb, Sn/Pb Eutectic and SnAg solder bumps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-3543</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Spin coating</td>
<td>High viscosity for taller copper-pillars and larger bumps (&gt;04 microns)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-3401</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Spin coating</td>
<td>Low viscosity for smaller pillars and bumps</td>
</tr>
<tr>
<td></td>
<td>Wafer-Level or Panel-Level Packaging Flux</td>
<td>WS-676</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Printing</td>
<td>0.5mm and smaller pitch wafer-level or panel level package</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-759</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Printing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-829</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Printing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flip-Chip Flux</td>
<td>WS-575-SP</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Jetting/Spraying</td>
<td>Sn/Pb Eutectic and SnAg onto SOP for logic flip-chip</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FC-NC-HT-A1</td>
<td>No-clean</td>
<td>Yes</td>
<td>Jetting/Spraying</td>
<td>Mass reflow flux compatible with CUF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-446</td>
<td>Water-wash</td>
<td>No</td>
<td>Dipping</td>
<td>Best flux for Poor solderability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-688</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Dipping</td>
<td>General purpose for multi-core logic flip-chip</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-841</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Dipping</td>
<td>For chip-on-wafer, high-density Cu-pillar application</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NC-26-A</td>
<td>Ultra-low residue no-clean</td>
<td>Yes</td>
<td>Dipping</td>
<td>Best compatibility with CUF/MUF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NC-26S</td>
<td>Ultra-low residue no-clean</td>
<td>Yes</td>
<td>Dipping</td>
<td>Avoids capillary flow up to die surface for fine-pitch devices</td>
</tr>
<tr>
<td></td>
<td>Ball-Attach Flux</td>
<td>NC-689</td>
<td>Near-zero residue</td>
<td>Yes</td>
<td>Dipping</td>
<td>Controlled solderability, compatible with wide variety of CUF/MUF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-446-AL</td>
<td>Water-wash</td>
<td>No</td>
<td>Pin Transfer</td>
<td>Best flux for poor solderability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-823</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Pin Transfer</td>
<td>Best all-around halogen-free ball-attach flux, easily cleaned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-829</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Printing and pin transfer</td>
<td>For sphere size &lt;0.25mm and fine-pitch high-density ball-attach, best cleanability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NC-585</td>
<td>No-clean</td>
<td>Yes</td>
<td>Pin Transfer</td>
<td>Good wetting onto bare nickel for 0.5mm pitch or lower BGA/PGA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-575-C-R</td>
<td>Water-wash</td>
<td>NIA</td>
<td>Pin Transfer</td>
<td>Best ball-attach flux for missing ball</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NC-809</td>
<td>Ultra-low residue no-clean</td>
<td>Yes</td>
<td>Dipping</td>
<td>Enhanced wetting, compatible with wide variety of CUF/MUF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WS-446HF</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Dipping</td>
<td>Suitable for no-clean process, good wetting onto gold surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PicoShot® WS-5M</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Jetting</td>
<td>For dot jetting of 300μm diameter and above, and fine-line dispensing for metal lid-attach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PicoShot® NC-5M</td>
<td>Solvent- or aqueous-based chemistry</td>
<td>Yes</td>
<td>Jetting</td>
<td>For dot jetting of 300μm diameter and above, and fine-line dispensing for metal lid-attach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indium12.8HF</td>
<td>Solvent- or aqueous-based chemistry</td>
<td>No-clean</td>
<td>Jetting and Microdispensing</td>
<td>For dot jetting down to 80μm diameter and above, and fine-line dispensing for metal lid-attach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SiPaste® 3.2HF</td>
<td>Water-wash</td>
<td>Yes</td>
<td>Printing</td>
<td>Type 6, Type 7, and Type 8 solder paste suitable for ultrafine-pitch printing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SiPaste® 201HF</td>
<td>DI water + saponifier or semi-aqueous chemistry</td>
<td>Yes</td>
<td>Printing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SiPaste® SMDQ7</td>
<td>No-clean</td>
<td>Yes</td>
<td>Dipping/Dispensing/Jetting</td>
<td>Holding die, chip, and preform in place, for formic acid reflow</td>
</tr>
</tbody>
</table>

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