Optimization of LOCA Gap Fill Process by High Precision Slot Die

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Adhesive = LOCA

- Liquid Optical Clear **Adhesive** (LOCA) is well known material for touch panel display and flexible sensors. Since LOCA was used for touch panel display, many non-uniformity issues and fill process issues are reported. High precision Slot Die solved these issues, instead of dispenser nozzle. This paper explain new coating technique by high precision Slot Die.
Over view of Slot Die

- Tungsten Carbide lips
- Stainless steel lips
- Stainless steel body
- Coating Lip
- Inner Surface
- Cavity

Single substrate process
Device structure

• OCA tape is good material on less than 7 inch flat panel.
• On over 7 inch flat panel, the rework and the tact time, over flow are big issues.

Resistive type

- PET
- OCA 50um
- ITO Film
- ITO Film
- OCA 25-50um
- PC/Glass
- LCD

Capacitive type

- Cover (Glass/PC)
- OCA over 150um
- Touch Panel
- OCA over 150um
- LCD

Three Bond HP
## Device structures

<table>
<thead>
<tr>
<th>GG type</th>
<th>OGS type</th>
<th>on-cell type</th>
<th>in-cell type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>Cover</td>
<td>Cover</td>
<td>Cover</td>
</tr>
<tr>
<td>LOCA 100-175um</td>
<td>Touch sensor</td>
<td>LOCA over 200um</td>
<td>LOCA over 200um</td>
</tr>
<tr>
<td>Touch sensor</td>
<td>LOCA over 200um</td>
<td>Touch sensor</td>
<td>Touch sensor</td>
</tr>
<tr>
<td>Glass</td>
<td>LCM</td>
<td>OLED</td>
<td>LCM</td>
</tr>
<tr>
<td>LOCA over 200um</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The location of L-OCA

1. 「Cover Glass」+「Touch sensor」
2. 「Touch sensor」+「LCM」

- with SUS frame
- without SUS frame less

**【G1F type】**

- Cover
- Touch sensor
- OCA
- Touch sensor
- Film
- LOCA over 200um
- LCM
How to use LOCA in the production

Optical Elasticity Resin (SVR®)

1. SVR® dispensed on cover glass
2. Cover glass flipped and bonded to display
3. Resin spread and pre-cured
4. Fully Cured

PSA-Transformed Optical Elasticity Resin (Hybrid SVR™)

1. Hybrid SVR™ coated on cover glass
2. It transformed from liquid resin to PSA
3. Pre-Cured
4. Bonded to Display
5. Fully Cured
Requirement of LOCA coat

- Short tact time
- Non over flow of LOCA
- No bubble & No streak
Conventional dispense nozzle process for L-OCA

Issues

1. Long tact time by nozzle painting
2. Over flow of LOCA $\rightarrow$ Excess coat of LOCA
3. Air bubble

Over flow of LOCA
Slot Die process for L-OCA

Progress
1. Short tact time by Slot Die
2. Non over flow of LOCA $\rightarrow$ Proper coat of LOCA
3. No air bubble

L-OCA requirement
3,000 - 50,000cps
Coating THK: 7" = 100 - 200um $\rightarrow\rightarrow$ 42" = 800um
Progressed coating method by Slot Die

Conventional structure

Impossible

Progressed structure

This invention is patent pending.

Tungsten Carbide Long Nose Lip
Conventional structure

Progressed structure

Coating width
Experiments of Coating

LOCA =5,000-7,000CPS Hybrid  
Target wet THK=100um

Step1: Initial purge
Step2: Coating (Filling)
LOCA = 5,000-7,000 CPS Hybrid, Target wet THK = 100um, Coating velocity = 15mm/sec
LOCA = 5,000-7,000 CPS Hybrid, Target wet THK = 100um, Coating velocity = 30mm/sec
Without the frame.
LOCA = 5,000-7,000 CPS Hybrid, Target wet THK = 100um, Coating velocity = 80mm/sec
LOCA = 5,000-7,000 CPS Hybrid, Target wet THK = 100um, Coating velocity = 80mm/sec
With Double Frame
Tungsten Carbide Long Nose Lip

\[ T = T_1 = T_2 = T_2 \]

\[ 3T \leq L \leq 18T \]

\[ T = 0.2\text{mm}-0.5\text{mm} \]
Comparison data by Long Nose Lip, Stainless Steel vs Tungsten Carbide

Same dimension and same structure of Long Nose Lip
Target wet THK=100um

<table>
<thead>
<tr>
<th></th>
<th>SUS</th>
<th>Tungsten Carbide</th>
</tr>
</thead>
<tbody>
<tr>
<td>THK</td>
<td>Non homogeneous</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>LOCA</td>
<td>Lack rigidity</td>
<td>Enough rigidity</td>
</tr>
<tr>
<td>Max</td>
<td>107.93 μm</td>
<td>100.86 μm</td>
</tr>
<tr>
<td>Min</td>
<td>97.45 μm</td>
<td>98.06 μm</td>
</tr>
<tr>
<td>Div</td>
<td>102.93 μm</td>
<td>2.80 μm</td>
</tr>
<tr>
<td>Avg</td>
<td>102.93 μm</td>
<td>99.53 μm</td>
</tr>
<tr>
<td>Unif</td>
<td>5.09 %</td>
<td>1.41 %</td>
</tr>
<tr>
<td>Edge drop</td>
<td>1.16 mm</td>
<td>0.72 mm</td>
</tr>
</tbody>
</table>

Target wet THK=100um
Coating velocity = 0.9m/minute
Tungsten Carbide Long Nose Lip  \( L \leq 18T \)

- \( L = 5.5 \text{mm} \)
- Target wet THK=100um,
- Coating gap=125um
- Lip gap=0.5mm
- Coating area = 90.8mm × 52.4mm
- LOCA = 5,000-7,000CPS Hybrid

\[
\begin{array}{|c|c|c|}
\hline
L & T & \text{LOCA} \\
\hline
5.4 & 0.3 & 5,000-7,000CPS Hybrid \\
5.6 & 0.3 & 5,000-7,000CPS Hybrid \\
\hline
\end{array}
\]
Data comparison on Flow direction by coating velocity

Bump height=19.53 μm

Bump height=18.49μm

L=5.5mm, Target wet THK=100um, Coating gap=125um
Lip gap=0.5mm, Coating area = 90.8mm × 52.4mm
LOCA =5,000-7,000CPS Hybrid
Data comparison on Flow direction by coating velocity

Bump height=20.88 μm

Bump height=18.75μm

L=5.5mm, Target wet THK=100μm, Coating gap=125μm
Lip gap=0.5mm, Coating area = 90.8mm × 52.4mm
LOCA =5,000-7,000CPS Hybrid
Data comparison on Flow direction by coating velocity

Bump height = 19.46 μm

L = 5.5 mm, Target wet THK = 100 μm, Coating gap = 125 μm
Lip gap = 0.5 mm, Coating area = 90.8 mm × 52.4 mm
LOCA = 5,000-7,000 CPS Hybrid
Data comparison on WEB direction by coating velocity

Bump height=13.94 μm

Bump height=11.87 μm

L=5.5mm, Target wet THK=100um, Coating gap=125um
Lip gap=0.5mm, Coating area = 90.8mm × 52.4mm
LOCA =5,000-7,000CPS Hybrid
Data comparison on WEB direction by coating velocity

Bump height=10.53 um

30mm/sec WEB direction profile

Bump height=11.95 um

40mm/sec WEB direction profile

L=5.5mm, Target wet THK=100um, Coating gap=125um
Lip gap=0.5mm, Coating area = 90.8mm × 52.4mm
LOCA =5,000-7,000CPS Hybrid
Data comparison on WEB direction by coating velocity

Bump height=10.75 um

L=5.5mm, Target wet THK=100um, Coating gap=125um
Lip gap=0.5mm, Coating area = 90.8mm × 52.4mm
LOCA =5,000-7,000CPS Hybrid

Bump height=10.23um

BEST
Previous our study of bump reduction

Present bump issue (Ski jump)
Combination issue by Slot Die and Valve, Pump.
- Slot Die: Precision cut, Coating position → Intermittent
- Valve: 3way quickness → succession&return
- Pump: frequency → Micro Mohno or Syringe

The present requirement for smart pad except i-Pad.
Previous our study of bump reduction

Trend of coating gap vs Ski Jump(Bump), Coating width
Coating width: 246mm  Target Wet THK: 100um(WET)

The inverse proportion
Ski Jump(Bump) vs Coating width
Conclusion

1. Tungsten Carbide Long Nose is useful to LOCA process for Sensor and Touch panel.
2. Stainless Steel Long Nose is not enough rigidity for this process.
3. Tungsten Carbide Long Nose outperformed to Stainless steel Long Nose.
4. It seems that higher coating velocity is suitable for this process.
5. Tungsten Carbide Long Nose Length must be $3T \leq L \leq 18T$ & $T=0.2\text{mm}-0.5\text{mm}$ in this study.
6. In previous our study explained How to reduce the bump.