Company History

1995
Established DSI Inc.

2000
Start R&D of ACF & IPD
Change company name to TELEPHUS

2005
Enter ACF & IPD market
Inauguration of President Jung-Hee Kim

2007
Specialized in ACF
IPD Biz. was acquired by Samsung

2009
Changed company name to H&S HighTech

2011
Factory relocation & Expansion

2012
M&A ACF Biz. of EXAX Inc.
M&A Crystal Biz. of KQT

2013
M&A ACF Biz. of LG Innotek

IPD : Integrated Passive Device
Company Profile

Seongnam Office: Sales & Administration
Address: 106-2 Imae-Dong, Bundang-gu, Seongnam, Korea

Company Name: H&S HighTech Corp.
President: J.H. Kim
Establishment: Dec, 1995
Employees: 150 Persons
Main Products: ACF, Crystal Oscillator, OCR

Headquarter:
ACF Division / ED division
(R&D, Production, QA)
Address: 757-2 Gwanpyeong-Dong, Yuseong-Gu, Daejeon, Korea
Total Area: 4,500 m²
Office Area: 1,300 m²
Factory Area: 3,200 m²
Clean Room: 1,000 m² (1000 Class)

Yantai Factory
Electronics Device division
Address: #89 Huanghai Road, Yantai City, Shandong Province, P.R. China
Factory Area: 3,000 m²
Clean room: 1.200 m²

Human & Science
売上推移

単位：韓国ウォン

<table>
<thead>
<tr>
<th>年度</th>
<th>ACF</th>
<th>電子部品</th>
<th>合計</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>280</td>
<td>136</td>
<td>416</td>
</tr>
<tr>
<td>2013</td>
<td>371</td>
<td>149</td>
<td>520</td>
</tr>
<tr>
<td>2014</td>
<td>305</td>
<td>146</td>
<td>451</td>
</tr>
</tbody>
</table>
Capa. 及び納期

● Capa.

<table>
<thead>
<tr>
<th>ACF 長さ/Reel</th>
<th>Full Capacity (2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100m/Roll</td>
<td>320,000 Roll (32KK m) / Month</td>
</tr>
</tbody>
</table>

● 納期（P/O 発行後）

<table>
<thead>
<tr>
<th>納品先</th>
<th>納期</th>
</tr>
</thead>
<tbody>
<tr>
<td>韓国</td>
<td>7 日 [韓国内陸送]</td>
</tr>
<tr>
<td>海外</td>
<td>14 日 [国際郵便またはforwarder]</td>
</tr>
</tbody>
</table>

● 保管条件 & 保証期間 & 取扱い注意事項

- 保管条件：-5℃〜5℃, 吸湿剤と同梱して密封保管
- 性能保証期間
  - 梱包状態：-5℃〜5℃ 条件下で6か月 (製品ラベル参照)
  - 開封状態：25℃, 75%RH 条件下で3週
  - 加圧着後：25℃, 75%RH 条件下で24時間

*注意事項
密封し冷蔵保管すること。
製品を冷蔵庫から取り出したのち30分後に使用すること。
What is the ACF?

1. Manufacturing Process
2. Composition
3. Application
Manufacturing Process

ACF is a connective material that satisfy 3 functions:

- Conduction
- Insulation
- Adhesion

Heat, Pressure and Time

Conductors Electrode/Bump

Substrate1: FPC or IC
Substrate2: Glass or PCB

Mixing process

Resin
Conductive particle

Coating Process

Mixing

Curing Agent
Resin & Additives

Mixture

Coating on Separator

Slitting process

Slitting

Cutting Knife

Reel

Winder

Rewinder
Composition of ACF -1

Binder

Thermoplastic type

Thermosetting type

Curing Agent

Particles

Carbon fiber

Metallic powder

Polymer (Ni, Au plating)

Insulation coating

Other Additives : Inorganic filler, Antioxidant, etc.

Phenoxy Acrylic etc.

Epoxy Urethane etc.

Ni Soldering Silver Etc.

Styrene Acrylic etc.

Polymer plating etc.

Conductive Particle, Size = 3~30 μm
(Au/Ni plated polymer beads or Ni particle)

Matrix adhesive system
(Thermoset & thermoplastic resin mixture)
Thickness = 4~50 μm

Release film (PET)
### Composition of ACF -2

<table>
<thead>
<tr>
<th>Application</th>
<th>Touch/OLB/CM</th>
<th>PCB</th>
<th>COG/COF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Conductor</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>Dendrite type</td>
<td>Spherical type</td>
</tr>
<tr>
<td>Remarks</td>
<td>Plastic: PS, PMMA, etc. 3um~30um (Ni:~0.15um/Au:~0.05um)</td>
<td>Only Nickel Or Au/Ni</td>
<td>`</td>
</tr>
</tbody>
</table>
ACF application

- Camera module [CMOS sensor/TCP]
- TAB Bonding Input [TCP / LCD]
- PCB Bonding Output [TCP / PCB]
- FOG bonding [FPCB / PET]
- FOG bonding [FPCB / LCD]
- Fingerprint Recognition Sensor [FOB/FOF]
- COG bonding [IC / LCD]

Touch screen panel
Introduction to H&S ACFs
### Film Type

<table>
<thead>
<tr>
<th>Bonding Condition</th>
<th>Normal cure</th>
<th>Adhesion Improve</th>
<th>Fast cure</th>
<th>Low Temp. &amp; Fast cure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150<del>160℃ / 10</del>15sec</td>
<td>150<del>160℃ / 10</del>15sec</td>
<td>140~160℃ / 5sec</td>
<td>120℃ / 10sec</td>
</tr>
<tr>
<td>150<del>160℃ / 10</del>15sec</td>
<td>150<del>160℃ / 10</del>15sec</td>
<td>140~160℃ / 5sec</td>
<td>120℃ / 10sec</td>
<td></td>
</tr>
<tr>
<td>130~160℃ / 10sec</td>
<td>140~160℃ / 5sec</td>
<td>120℃ / 10sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>130℃/5sec</td>
<td>120℃ / 10sec</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>20um</th>
<th>10um</th>
<th>20um</th>
<th>10um</th>
<th>20um</th>
<th>10um</th>
<th>20 / 10um</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>TGP20520AG</th>
<th>TOU2051AS</th>
<th>TCH8020MP</th>
<th>TCH8010MP</th>
<th>TOU5000SP</th>
<th>TOU5010SP</th>
<th>TOU_ Series</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Remark</th>
<th>Normal type.</th>
<th>Improved bubble issue &amp; adhesion with PET.</th>
<th>Low temperature bonding type. Improved bubble issue.</th>
<th>Under Development</th>
</tr>
</thead>
</table>

### Glass Type

<table>
<thead>
<tr>
<th>Bonding Condition</th>
<th>Normal cure</th>
<th>Low temp. cure</th>
<th>Low temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>130~150℃ / 10sec</td>
<td>130~170℃ / 5sec</td>
<td>140~180℃ / 4sec</td>
</tr>
<tr>
<td>130~150℃ / 10sec</td>
<td>130~170℃ / 5sec</td>
<td>140~180℃ / 4sec</td>
<td>120~160℃ / 4sec</td>
</tr>
<tr>
<td>130℃/5sec</td>
<td>120~160℃ / 4sec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>20um</th>
<th>10um</th>
<th>4um</th>
<th>20um</th>
<th>10um</th>
<th>5/4um</th>
<th>10/5um</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>TOU3020CP</th>
<th>TOU3010CP</th>
<th>TOU8810JP</th>
<th>TSC3140TY</th>
<th>TOU5000YZ1</th>
<th>TOU5010DY</th>
<th>TSC535(4)0 series</th>
<th>TOU_ Series</th>
</tr>
</thead>
</table>

| Remark | Applicable on the Ag(BM coated on the glass), ITO and Metal electrode. | | Under development | |
|--------|-------------------------------------------------------------------|-------------------|-------------------|
## H&S Product Line Up – FOG&COG

### FOG

<table>
<thead>
<tr>
<th>Item</th>
<th>Normal cure</th>
<th>Fast cure</th>
<th>Fast cure &amp; Low temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bonding Condition</strong></td>
<td>180~190℃ / 10sec</td>
<td>180~190℃ 7sec</td>
<td>160<del>200℃ 5</del>10sec</td>
</tr>
<tr>
<td><strong>Conductor Size</strong></td>
<td>10um</td>
<td>5um</td>
<td>4um</td>
</tr>
<tr>
<td><strong>Item</strong></td>
<td>TSC22000N</td>
<td>TSC3050BP</td>
<td>TSC3140TY</td>
</tr>
</tbody>
</table>

### COG

<table>
<thead>
<tr>
<th>Item</th>
<th>High-temp cure</th>
<th>Middle-temp cure</th>
<th>Low-temp cure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td>TCG1031GY</td>
<td>TCG9031ME</td>
<td>TCG9031UN</td>
</tr>
<tr>
<td><strong>Bonding condition</strong></td>
<td>190~230℃/5sec</td>
<td>150~190℃/5sec</td>
<td>135~175℃/5s</td>
</tr>
<tr>
<td><strong>Conductor (Size)</strong></td>
<td>3μm, 4um</td>
<td>Insulation coated</td>
<td>3μm</td>
</tr>
</tbody>
</table>

- **Remark (TCG9031UN):** Ultra-low temperature. Overlap area: 500μm²
- **Remark (TCG9031UN):** Very good Storage stability. Concentration: 1.3
H&S Product Line Up – Camera Module

**Camera Module**

<table>
<thead>
<tr>
<th>Item</th>
<th>TSB21000SD</th>
<th>TSB21001F</th>
<th>TSB20522F</th>
<th>TCM5010UZ</th>
<th>TCM5015UZ3</th>
<th>TCM5000UZ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy grade</td>
<td></td>
<td></td>
<td></td>
<td>140~170℃</td>
<td>140~170℃</td>
<td>130~180℃</td>
</tr>
<tr>
<td>Bonding Condition</td>
<td>180~200℃  &gt;15Sec</td>
<td>180~200℃ ≥7Sec</td>
<td>180~200℃ ≥7Sec</td>
<td>140~170℃ ≥10Sec</td>
<td>140~170℃ ≥10Sec</td>
<td>130~180℃ ≥6Sec</td>
</tr>
<tr>
<td>Conductor Size</td>
<td>Normal type</td>
<td>Soft type</td>
<td>soft + hard</td>
<td>Soft type</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10μm</td>
<td>10μm</td>
<td>8+20μm</td>
<td>10μm</td>
<td>15μm</td>
<td>20μm</td>
</tr>
<tr>
<td>Remark</td>
<td>Normal type</td>
<td>Fast cure &amp; goo adhesion.</td>
<td>To protect electrical open, used the mixed ball. (metal + polymer)</td>
<td>Low temp. good adhesion.</td>
<td>-</td>
<td>Low temp. good adhesion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Decrease burr.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fingerprint Recognition Module**

<table>
<thead>
<tr>
<th>Model</th>
<th>TGP5010UBH</th>
<th>TSB20522F</th>
<th>TCM5022UZ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding condition</td>
<td>140~200℃, ≥4Sec</td>
<td>180~200℃ ≥7Sec</td>
<td>130~180℃ ≥6Sec</td>
</tr>
<tr>
<td>Conductor(Size)</td>
<td>10μm</td>
<td>8+20μm</td>
<td>20+8μm</td>
</tr>
<tr>
<td>Remark</td>
<td>Waterproof / Reliability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## H&S Product Line UP – PCB&OLB

### PCB

<table>
<thead>
<tr>
<th>Model</th>
<th>High cure</th>
<th>Low cure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TGP20505N</td>
<td>EMA8888E</td>
</tr>
<tr>
<td>Bonding Condition</td>
<td>180 ~ 200°C / 8sec</td>
<td>130 ~ 190°C / 4sec</td>
</tr>
<tr>
<td>Conductor (size)</td>
<td>5μm</td>
<td>3μm</td>
</tr>
</tbody>
</table>

### OLB

<table>
<thead>
<tr>
<th>Model</th>
<th>High-temp</th>
<th>Middle-temp</th>
<th>Low-temp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TSC4330AY</td>
<td>EMA7870B</td>
<td>TSC5340NY</td>
</tr>
<tr>
<td>Bonding condition</td>
<td>150~200°C/4sec</td>
<td>170(±20)°C / 4~10sec</td>
<td>130~180°C/4sec</td>
</tr>
<tr>
<td>Conductor (Size)</td>
<td>3um</td>
<td>3um</td>
<td>3/4um</td>
</tr>
<tr>
<td>Remark</td>
<td>Fine pitch 1layer (ACF)</td>
<td>Good Adhesion 2layer (ACF/NCF)</td>
<td>Fine pitch, Low-Temp. &amp; Fast cure. 2layer (ACF/NCF)</td>
</tr>
</tbody>
</table>
### H&S技術/製品の差別化

#### 新技術先行導入

<table>
<thead>
<tr>
<th>指紋認証適用</th>
<th>耐塩水性</th>
<th>多様なFlexible基材を適用</th>
<th>耐吸収性</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆SMTからACFへ初めて適用</td>
<td>◆強靭な耐塩水性効果</td>
<td>◆最近の韓国内Flexible市場が</td>
<td>◆多様な薬品条件の環境、多様な適用Applicationに対応</td>
</tr>
<tr>
<td>◆韓国C社へ適用し量産中</td>
<td>◆韓国S社へ適用し量産中</td>
<td>PET → COP基材へ変更するトレンドであり変更するための基材に最適な製品を開発</td>
<td>多様な製品条件の環境、耐えることができる高信頼性</td>
</tr>
</tbody>
</table>

#### 差別化/競争力

<table>
<thead>
<tr>
<th>広い工程マージン</th>
<th>Just In Time納期</th>
<th>迅速な顧客サービス</th>
<th>単価優位及び原価節減</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆高信頼性と長期信頼性確保</td>
<td>◆韓国内1W, 海外2週納期保証</td>
<td>◆ACF Bonding solution支援</td>
<td>◆競争社対比競争力ある価格で安定的な製品供給</td>
</tr>
<tr>
<td>◆顧客の工程に適合した組成開発によりACFのBondingマージン極大化</td>
<td>◆顧客のための十分な在庫確保</td>
<td>◆顧客現場VOC密着対応</td>
<td>◆生産規模拡大による資材価格引き下げ効果</td>
</tr>
<tr>
<td></td>
<td>◆Just In Time 納期実行</td>
<td>◆ISSUE, 不良に対する迅速な対応</td>
<td>◆原材料の韓国国産化と当社自主原料開発による単価節減</td>
</tr>
<tr>
<td></td>
<td></td>
<td>◆顧客製造Line模写評価体系構成</td>
<td></td>
</tr>
</tbody>
</table>
Test/Process condition Guide for Touch Panel
**Evaluation System** __Pressure, Temperature, Time -> Before Pre-bonding__

### Pressure condition

- In case of target pressure 3MPa(≒30kgf/cm²)
  - 0.25cm x 3cm = 0.75cm²
  - 0.75cm² x 30kgf/cm² = 22.5kgf

A pressure device is set up so that the pressure of 22.5kgf may be applied.

### Temperature condition

- 90% of target bonding temperature should be reached within 3 sec in case of 7sec bonding
Checking Flatness of Bonding Tool -> Before Pre-bonding

Pressure sensitive paper

Left/Right -balance NG
Forward/rear -balance NG
Tool tip -roughness NG

Tool balance OK

- A tool tip have to manage balance and surface of tip, because it might be caused bubble and uneven conductor deformation.
**Pre-bonding condition**

- **About pre-bonding pressure**

  The pre-bonding pressure and the temperature should be as low as possible since the purpose of pre-bonding is only for attaching ACF on the substrate.

  Below image shows the failure case due to excessive pre-bonding pressure. The ACF thickness is decreased due to severe resin overflow out of the base film. It would cause the lack of resin filling on the electrode & space, and would increase the possibility of bubble occurrence in the space.

---

{[Proper pre-bonding pressure]}

{[Excessive pre-bonding pressure]}

---

{Bubble-formation on the space due do the excessive pre-bonding pressure}
### Bubble formation – After Main Bonding

<table>
<thead>
<tr>
<th>Main reason</th>
<th>Failure factor</th>
<th>Example</th>
</tr>
</thead>
</table>
| **Resin Overflow**                   | • Excessive bonding temp.  
• Excessive bonding pressure  
• Low viscosity of ACF resin | ![Example Image](image1)

→ If bubble shape do not change during the reliability, it has no problem with the product function. |
| **Insufficient cure ratio**          | • Insufficient bonding temperature  
• Slow cure speed of ACF | ![Example Image](image2)

→ Increase contact resistance during reliability |
| **Delamination from substrates**     | • Excessive bonding pressure  
• Low adhesion with substrate  
• Reliability condition | ![Example Image](image3)

→ Increase contact resistance or reduce the adhesion during reliability |
How to define a Proper Bonding?

**Bonding temperature**
- If bonding temperature is too high, it might be thermal damage such as delamination between PET and silver electrode.
- If bonding temperature is insufficient, it might be bubbles in space or on electrode.

**Bonding pressure (conductor deformation)**
1. Before peel-off, method to observe through transparent PET or miss-aligned electrode.
   → *This method cannot observe through unclear substrates such as DPW (direct patterning window) to be coated black ink.*
2. After peel-off, method to observe conductor deformation in ACF residue on the electrode.
   → *Crushed ball size is smaller than ball size before peel-off, because of conductor's restoration property.*

![Images showing bonding temperature and pressure effects](image-url)
Heat loss due to FPC design

- Inefficient cure due to heat loss
  - It might be occurred bubble, because of inefficient cure due to heat loss, as a FPC design or controller IC position.
Typical problems in Bonding Process

- Bending of PET film due to bonding temperature
**Conductor deformation after peel-off / Mis-align**

<table>
<thead>
<tr>
<th>Low Pressure (&lt;1MPa)</th>
<th>Good (1.5~2.5MPa)</th>
<th>High Pressure (&gt;3MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Low Pressure Image" /></td>
<td><img src="image2" alt="Good Image" /></td>
<td><img src="image3" alt="High Pressure Image" /></td>
</tr>
</tbody>
</table>

- **Miss-align**
- **Peel-off**
- **Cross section**

- Due to the flexible property of PET and the softness of silver electrode and its surface unfitness, there might exists well deformed as well as less deformed conductor on the same electrode of Touch Panel Film sensor. The best way to judge the conductor deformation is to do miss-align bonding and observe the conductor crack status after peeling off FPC, the standard is as follows:

  **There should be at least 1~2 cracks per conductor, but not as too much cracks as to cause the outer plating layer been broken into pieces.**

<table>
<thead>
<tr>
<th>1 or 2 cracks</th>
<th>Plating layer almost broken into pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. standard</td>
<td>Max. standard</td>
</tr>
</tbody>
</table>
**Crushed conductor shape _ Glass+FPC**

<table>
<thead>
<tr>
<th>Low Pressure</th>
<th>Good</th>
<th>High Pressure (X 500)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- Above pictures is to be bonded using by transparent glass and PET, to observe conductor deformation.
- This data has no regard for silver electrode thickness.
Degree of cure – FT-IR method

FT-IR Microscope

Equipment: Bruker IFS 66V/S
Measurement mode: Bruker optics ATR mode
Resolution: 4 cm\(^{-1}\)
Wave range: 4000 to 600 cm\(^{-1}\)
Number of scan: 64 scan

Uncured Sample
Cured Sample

913 cm\(^{-1}\)
Degree of cure — DSC method

Cure ratio ($\alpha$)

$$\alpha \, (\%) = \left( 1 - \frac{H_T - H_R}{H_T} \right) \times 100$$

- $H_T$ = enthalpy before cure
- $H_R$ = enthalpy after cure

Measure change of the heat flow induced by curing.

* DSC (Differential Scanning Calorimetry)
# Ref. Test Equipment

## Analysis Equipment
- DSC (2)
- TGA
- DMA/TMA
- Rheometer
- Micro FT-IR (2)
- SEM
- GPC
- Warpage

## Characteristics Evaluation
- Bonder
- OLB
- PCB
- COG
- FOG (3)
- Microscope (5)
- Multi-tester (3)
- Contact Resistance
- Insulation Resistance

## Reliability Equipment
- TH (2)
- TC
- PCT
- High/Low Temperature Device (3)
- Salt-spray
- Dage
- UTM
- Push-Pull

## Mass Production Equipment
- Mixing System
- Filtering System
- Coater (5)
- Slitter (3)
- Probe Tack
- XRF

## Other
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Thank you!

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