Dexerials

Enabling Technology *for* Reliable Miniaturization of ADAS Sensors

Dexerials

Business Fields + Solutions

Electronics

Visibility | Reliability | Durability | Accuracy | Efficiency

Automotive

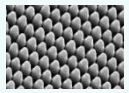
Advanced

Photonics

intellectual

Representative Products

Anti-Reflection Film



Moth-Eye films & Micro Lens Array

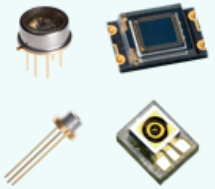
Optical Clear Resin

High Durable Optical Devices

Anisotropic Conductive Film(ACF)

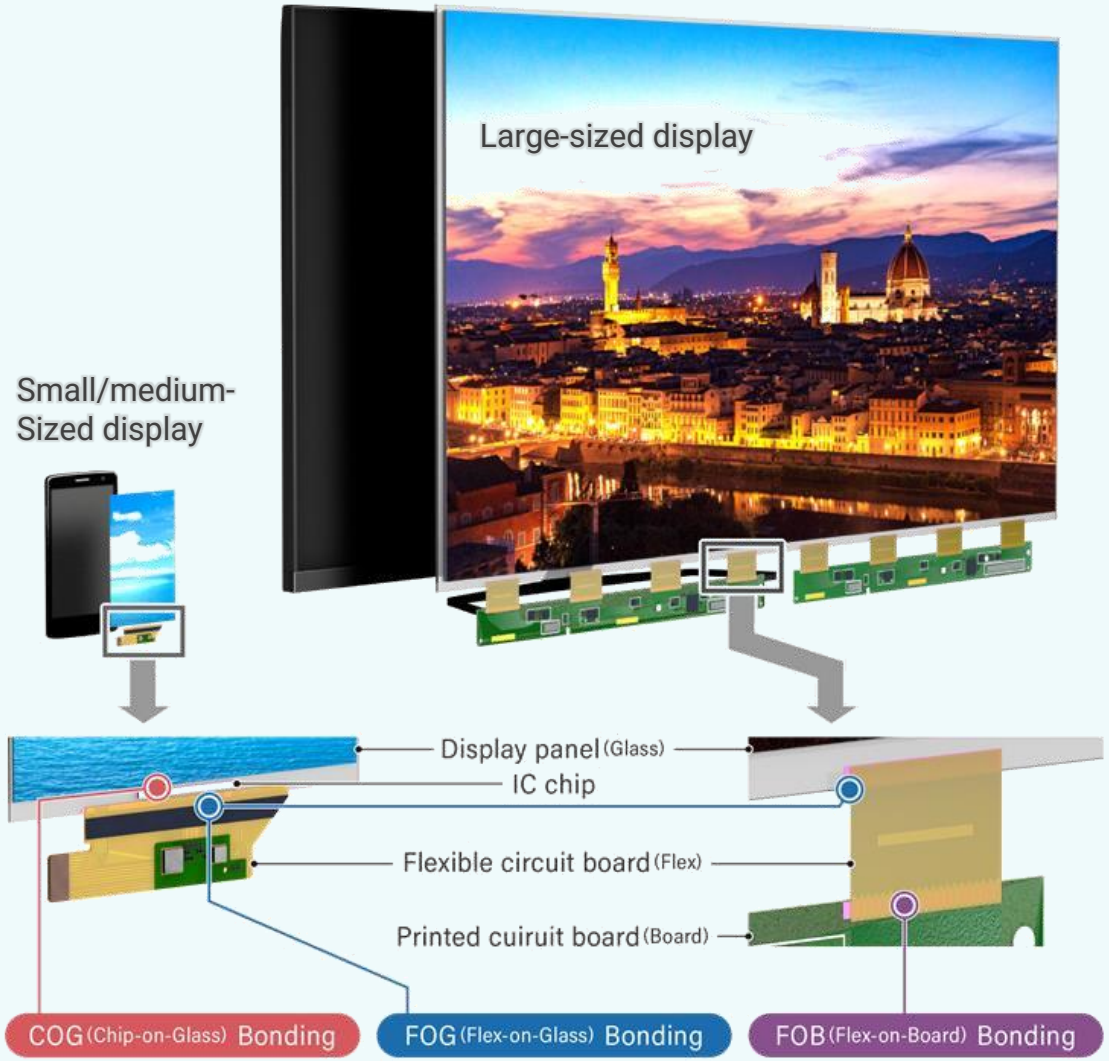
Optical Alignment Glue

Dexerials Photonics Solutions Corporation



- ✓ Cover UV or IR
- ✓ Industry-leading High-speed PD (30 GHz)
- ✓ 70 GHz under development

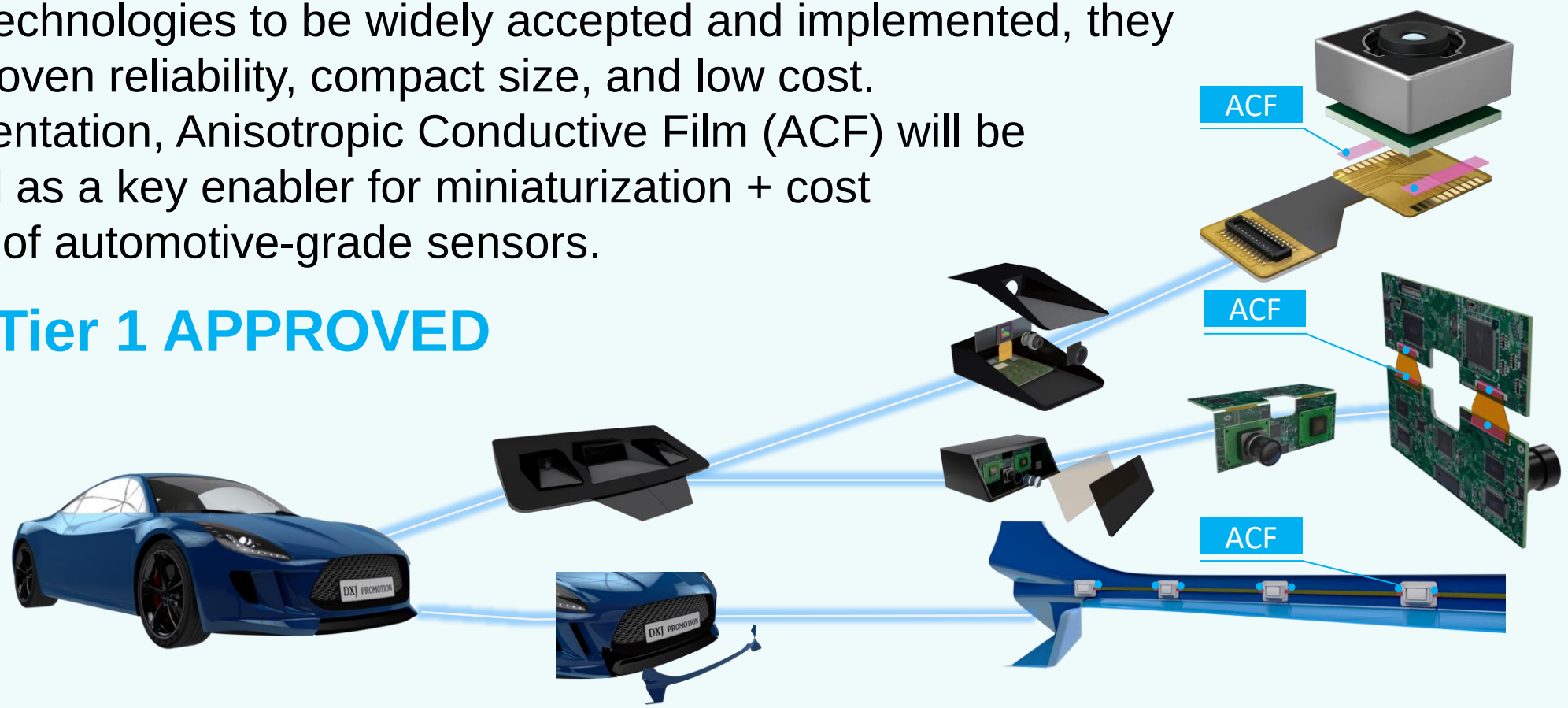
Anisotropic Conductive Film (ACF) Use Cases Today



- Conductive connection between driver IC/sensor module and circuit board
- De facto standard adhesive material used in almost all FPD (Flat Panel Display)
- Adopted for vehicle display

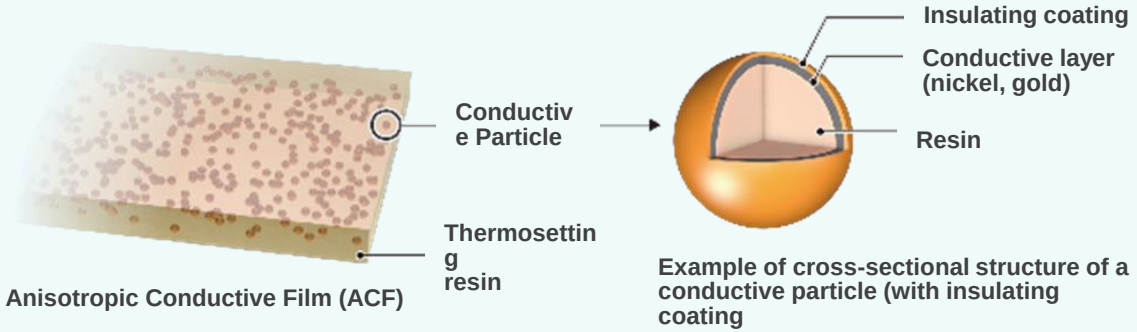
ACF for ADAS & AV Sensors

- Within the ADAS and AV industry, there is consensus that several different sensor types are required components of sensor suites for high levels of autonomy.
- For these technologies to be widely accepted and implemented, they require proven reliability, compact size, and low cost.
- In the presentation, Anisotropic Conductive Film (ACF) will be discussed as a key enabler for miniaturization + cost reduction of automotive-grade sensors.
- **OEM & Tier 1 APPROVED**

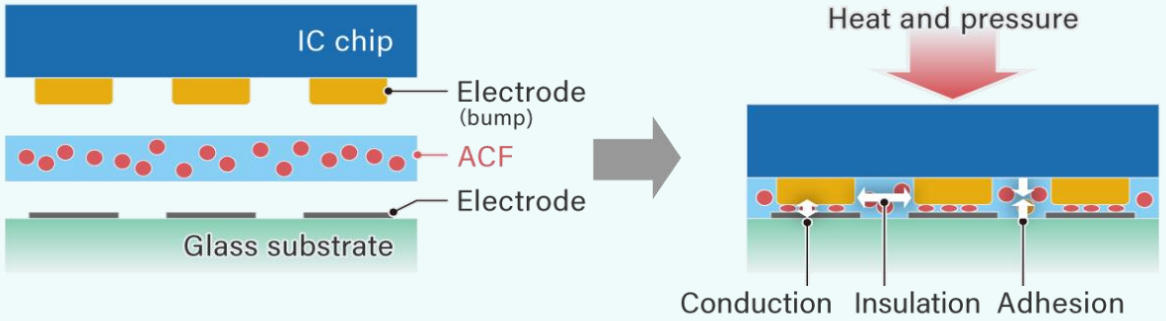


Structure and Functions of ACF

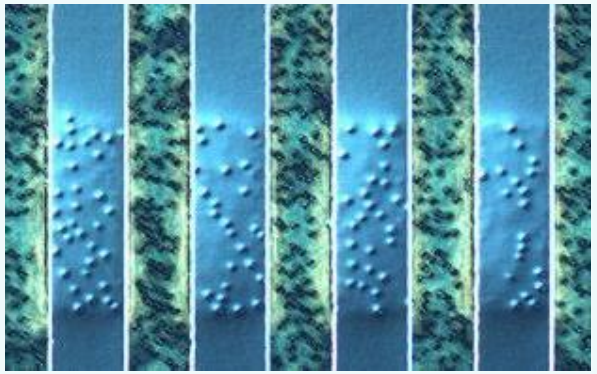
- Adhesive film in which conductive particles are scattered in thermoset resin



- Multiple electrodes are connected together by one-time thermal compression bonding.
- Capable of conduction, insulation, and adhesion simultaneously

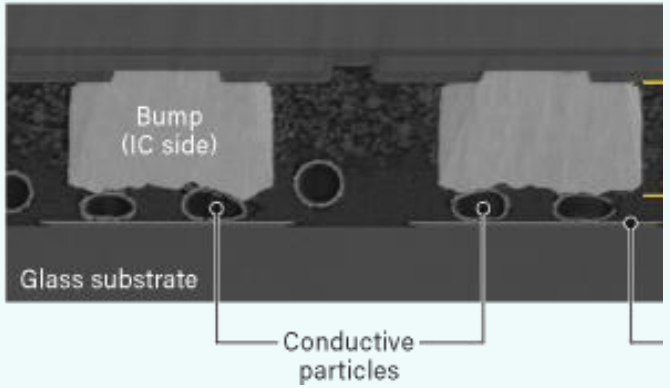


Microscope image of particle captured marks on terminals



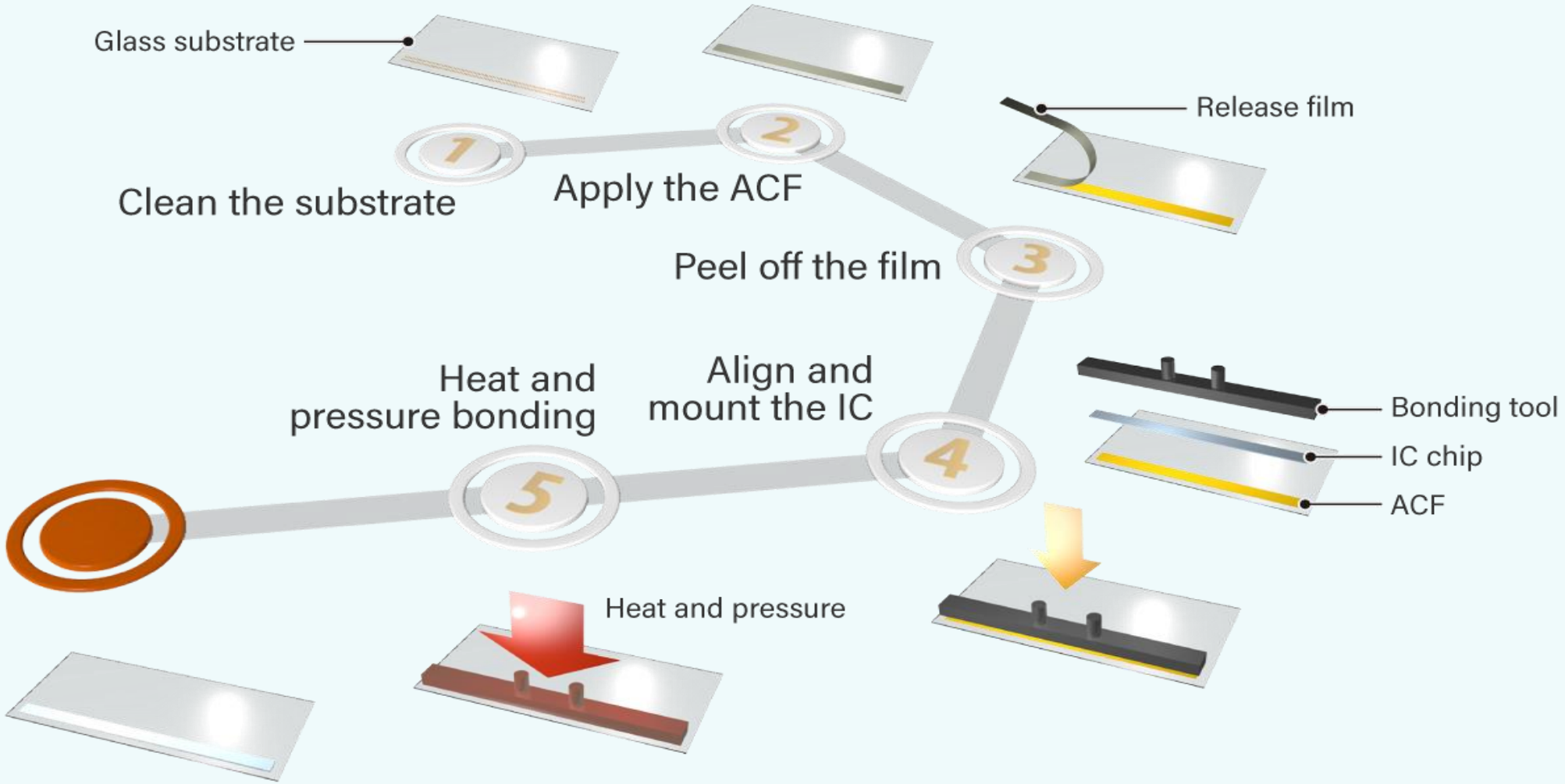
Particle size : ϕ3.5 μm
Particle area density : 20 kpcs/mm²

Cross-section of COG bonding - SEM image



ACF Bonding Process Flow

Example of COG bonding process using Anisotropic Conductive Film (ACF)



ACF Advantages over Conventional Bonding Materials

ATTRIBUTES	ACF	Solder	Mechanical Connector
Fine Pitch Connection	+++	++	+
Thin Connection	+++	+++	--
Low Temp + Short Time	++ e.g., 130-200℃ for 5 seconds	--	+++
Lead Free	+++	+	++

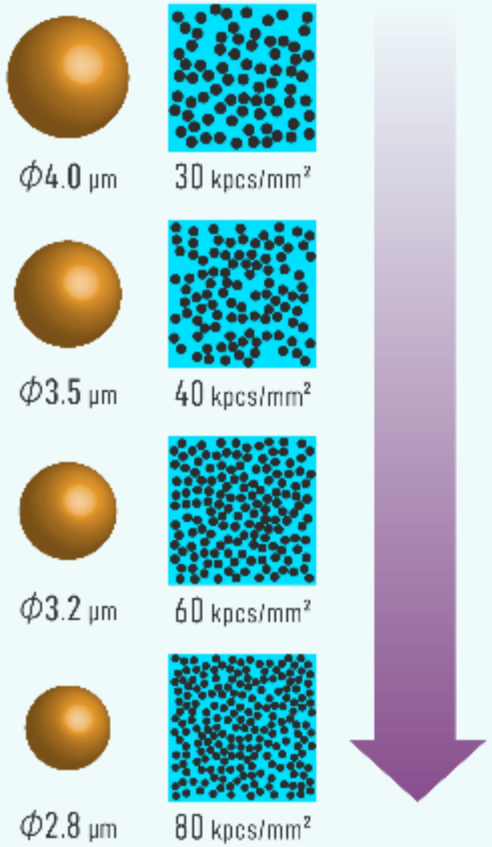
ACF Advantages:

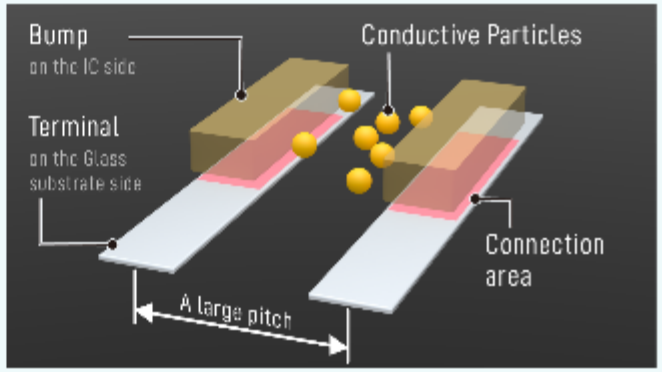
- Miniaturization by replacing mechanical connector
- Lower material consumption
- Reduced energy in manufacturing
- Reduced thermal effect on surrounding materials

- The adhesive film with dispersed conductive particles is a superior substitute for solder pastes or mechanical clips, both of which have inherent vulnerabilities when the form factor of sensors shrinks.
- By optimizing the particle size, film thickness, and particle configuration, these films ensure design freedom for variations in architecture, and safeguard that fine pitch applications can achieve reliable connectivity without the risk of shorts.

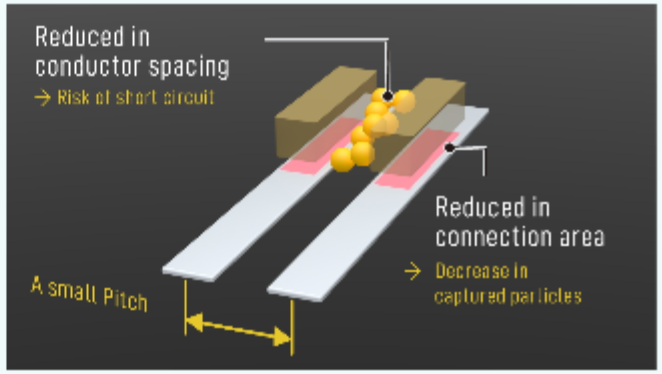
Need for Advanced Technology

Diameter and density of conductive particles in ACF





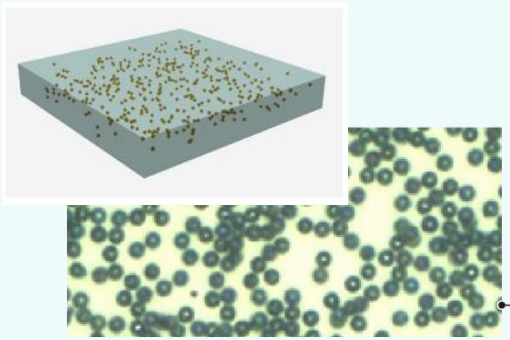
Decreased particles diameter and increased density to accommodate small connection area



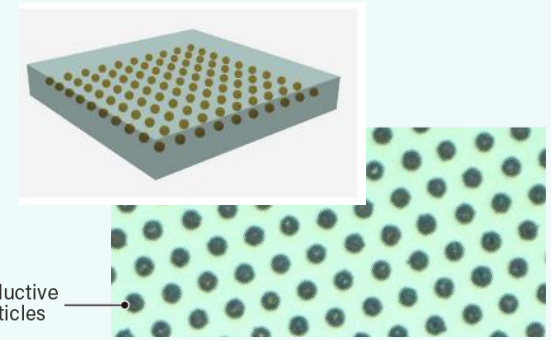
Approaching the limits of both terminal (bump) spacing and particle density

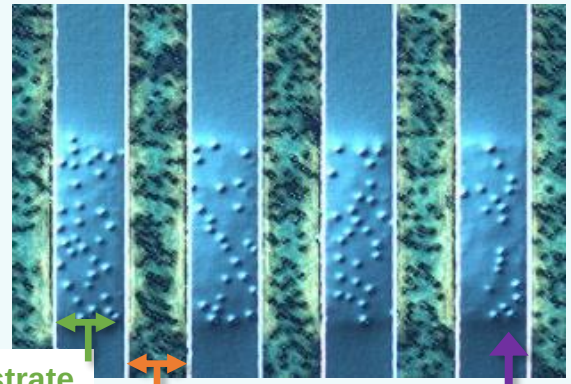
Comparison of Particle Configuration

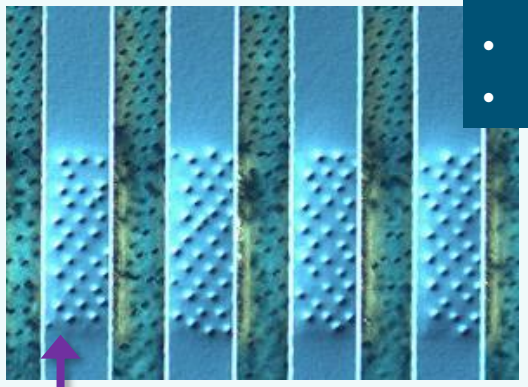
Conventional ACF



Particle-arrayed ACF







Particle-arrayed Type Achieves:
- small terminal spacing
- small connection area
- reliable particle capture

Terminal on the glass substrate

Space between terminals

Bond mark - impression mark of captured conductive particles

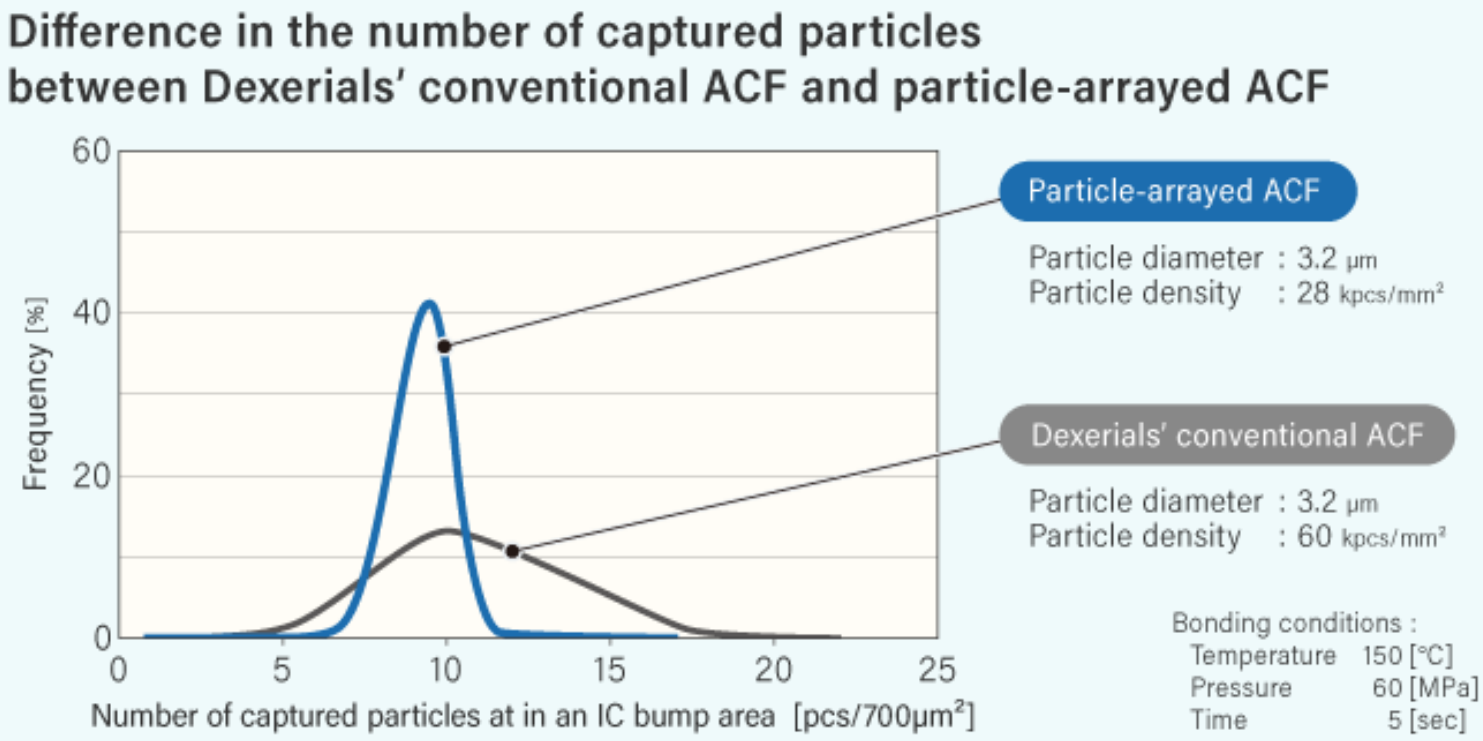
ACF General Specifications

- Conductive particles area density: 60K pcs/mm^2
- Minimum terminal spacing : 12 μm
- Minimum connection area : 1,300 μm^2

Particle-arrayed Type Specifications

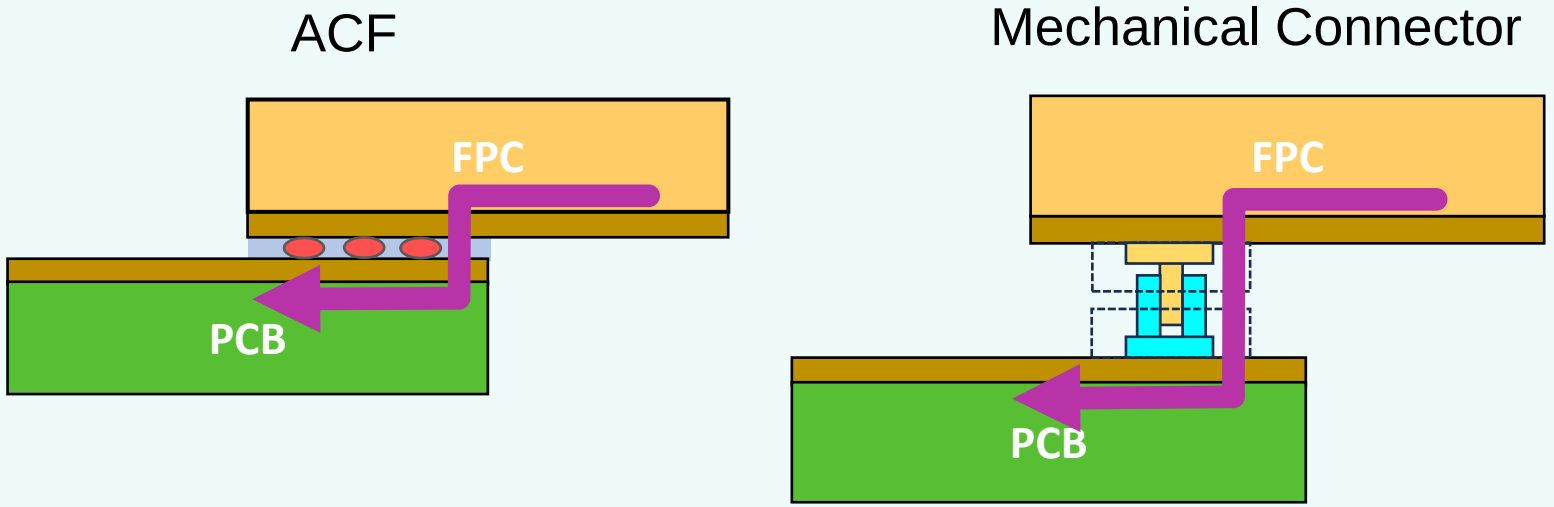
- Conductive particles area density: 28K pcs/mm^2 53% less
- Minimum terminal spacing: 10 μm 17% reduction
- Minimum connection area: 300 μm^2 77% reduction

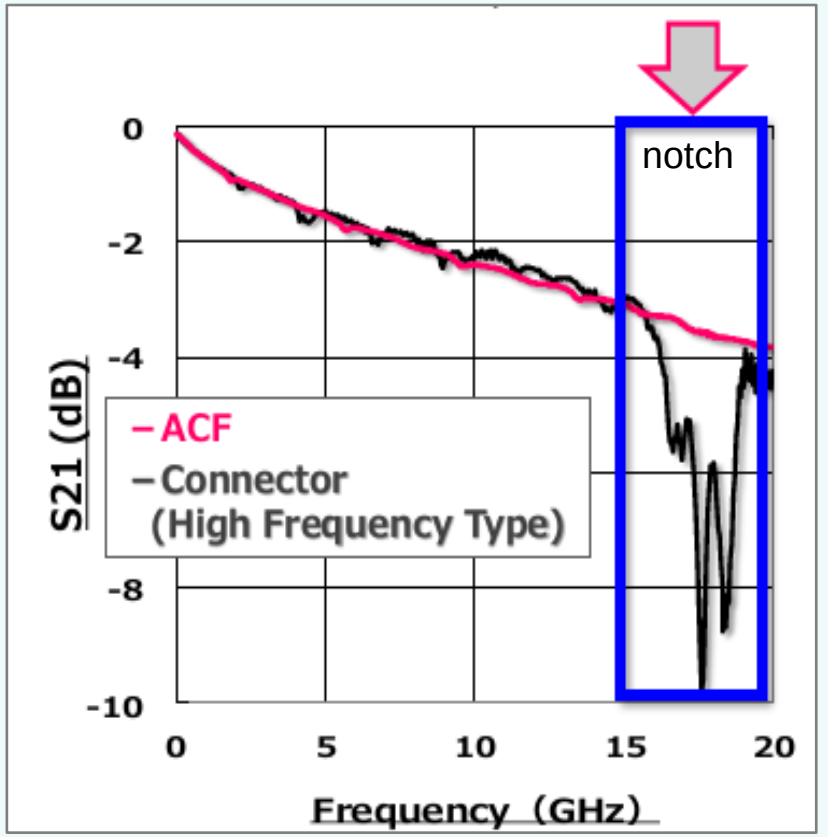
ACF and Particle-arrayed ACF Comparison



- The Particle arrayed ACF provides a more consistent number of captured particles due to its fixed configuration.
- Processing conditions (lamination, bonding, etc. are similar to conventional ACF).
- Multiple configurations are available to accommodate unique device designs.

ACF High Frequency Performance





Direct contact using ACF instead of mechanical connector can minimize the reflection at the connection points and eliminate the high frequency notch.

ACF is superior to mechanical connectors in terms of both miniaturization and high frequency performance.

ACF Reliability Overview

ACF Products perform well in typical automotive reliability test protocols, including:

- High temperature + high humidity
- Thermal cycling
- Thermal shock

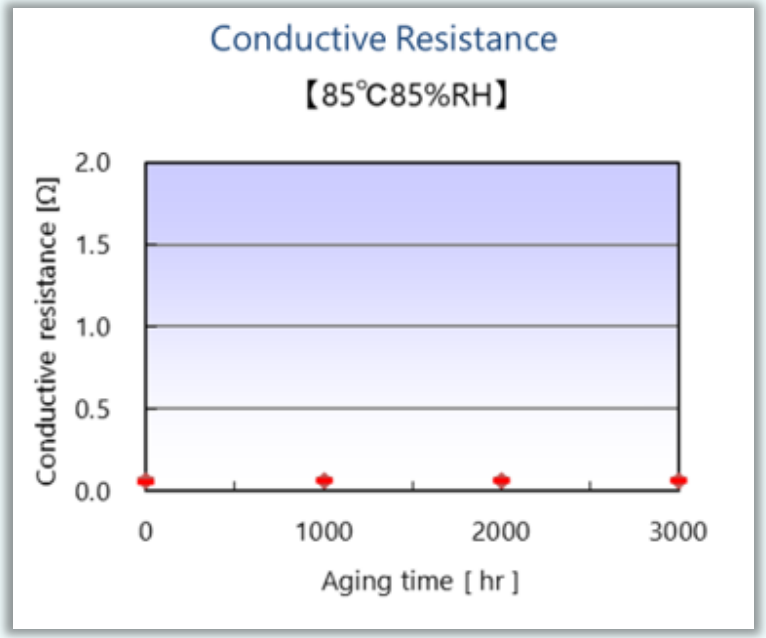
After being subjected to these extreme conditions, performance testing includes:

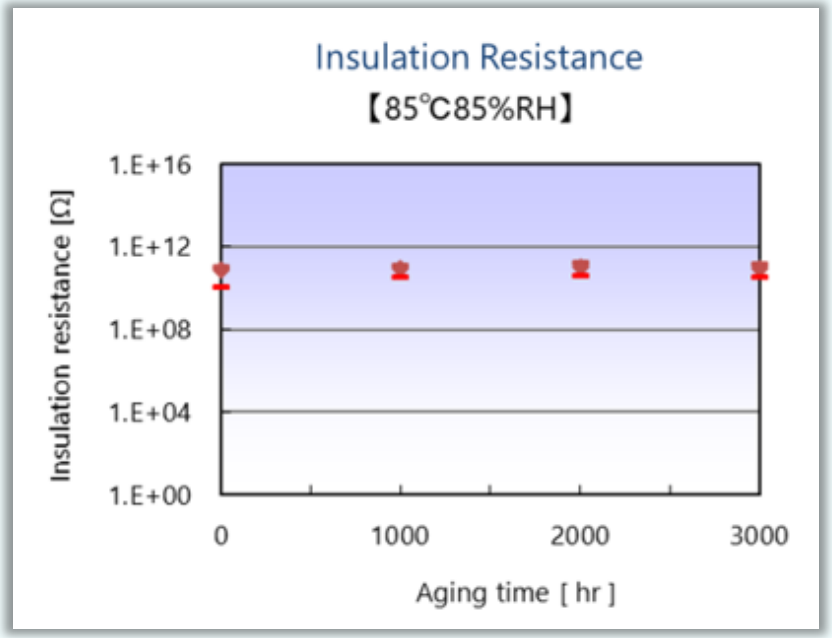
- Conductive resistance
- Insulation resistance

ACF Reliability – High Temp + High Humidity

- These graphs show the conductive resistance and insulation resistance after parts assembled with ACF were subjected to temperature and high humidity.
- ACF demonstrated robust performance after these automotive-type test conditions.
- ACF Product: CP881AM (Compliant with IATF16949)

Test Conditions:
Constant 85℃ / 85% RH

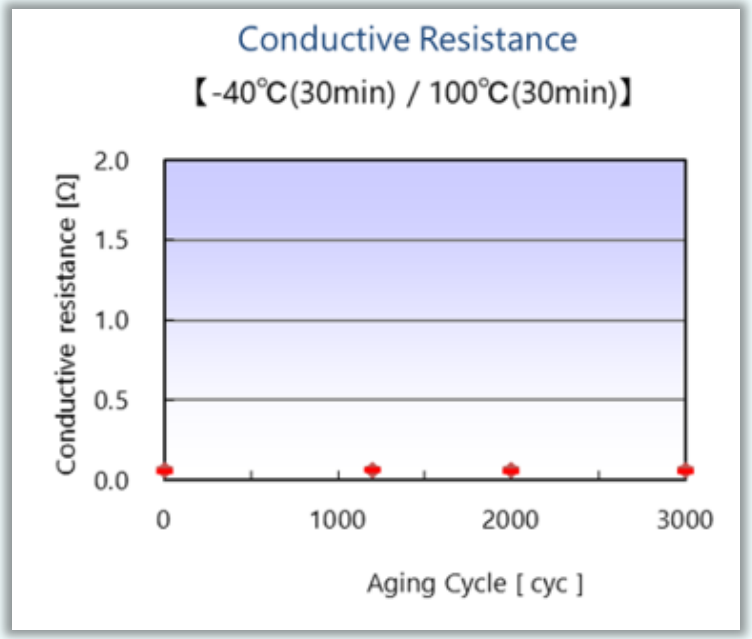


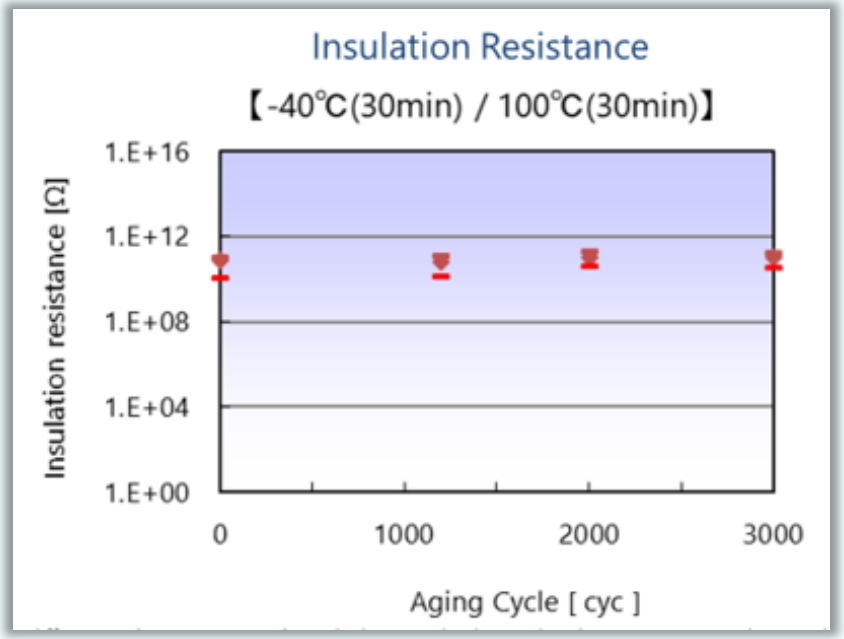


ACF Reliability – Thermal Cycling

- These graphs show the conductive resistance and insulation resistance after parts assembled with ACF were subjected to thermal cycling.
- ACF demonstrated robust performance after these automotive-type test conditions.
- ACF Product: CP881AM (Compliant with IATF16949)

Test Conditions:
-40℃ (30 min) → +100℃ (30 min)

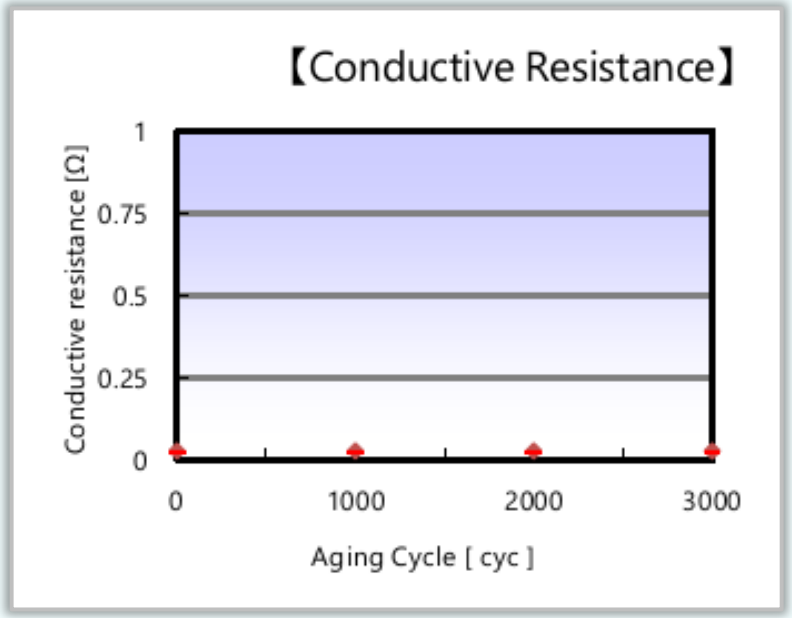


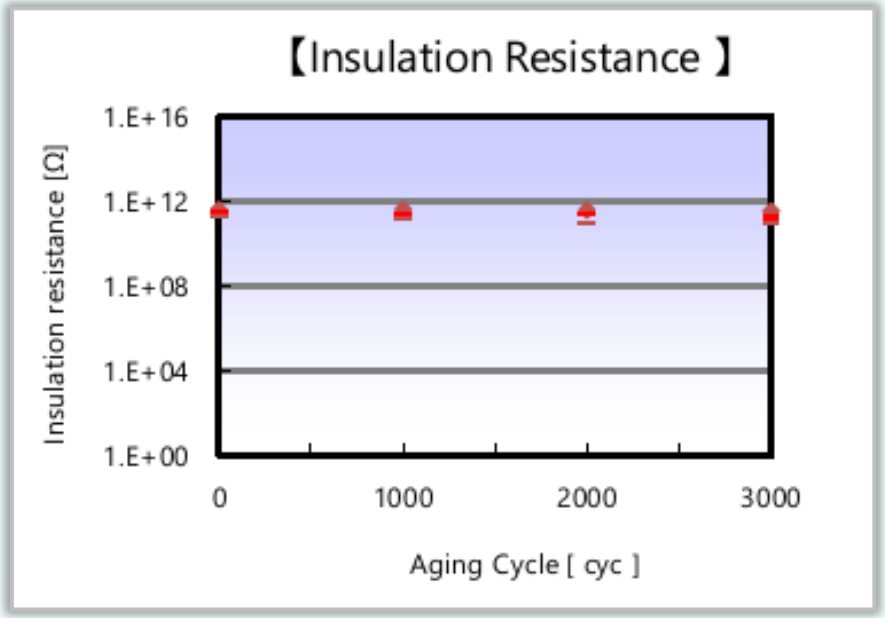


ACF Reliability – Thermal Shock

- These graphs show the conductive resistance and insulation resistance after parts assembled with ACF were subjected to thermal shock.
- ACF demonstrated robust performance after these automotive-type test conditions.
- ACF Product: CP881AM (Compliant with IATF16949)

Test Conditions:
-55℃/15 min. ←→ +125℃/15 min.
Transition time: 10 seconds





ACF: Key Takeaways

- Anisotropic Conductive Film (ACF) is capable of conduction, insulation, and adhesion simultaneously.
- ACF has a successful history of reliable performance.
  - ACF is currently in mass production at Tier 1 and OEM companies for automotive sensing cameras and LiDAR sensors.
  - When fine pitches approach the limits of ACF, Particle-arrayed ACF provides a solution.
- ACF offer several advantages over conventional bonding materials.
- The small form factor of ACF can facilitate miniaturization for many types of ADAS sensor designs.
- ACF can accommodate the transmission speeds required for ADAS sensors.

Thank you for your attention