Layered Copper and Aluminum Composites and Applications

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* Iron(steel), Aluminum, Copper are three volume metals in the market.

* Copper, the third largest metal species after iron & steel and aluminum, possesses excellent electrical and thermal conductivity and strong corrosion resistance, is considered as electrical and thermal conductor of choice, but limited by resource-poor and high cost.

* Aluminum, the second largest metal species after iron & steel, possesses small density, good electrical and thermal conductivity, and mechanical ductility, its reservation in the earth is ranked three only preceded by oxygen and silicon, resource-rich and low cost.
Copper Clad Aluminum Composites

* Copper clad aluminum composite ("CCAC"), possesses physical, chemical and mechanical properties of copper and aluminum, is characterized as good electrical and thermal conductivity, good corrosion resistance, light weight and affordability.

* CCAC not only provides solutions to aluminum in welding, ceasing-arc, less wearable, but also resolves the issues of copper in heavy mass, low intensity, resource-poor and high-cost of application limitations.
Layered Copper Clad Aluminum Composites

The bimetal interface of CCAC has achieved metallic bonding and generated intermediate compounds due to fabrication processing.

The layered CCAC, structured as three layers comprising of copper cladding layer, aluminum core layer and metallurgical bonding layer, possesses various advanced physical and mechanical properties, along with anti-blast, superior intensity and strength of anti-vibration fatigue, which beyond a single metal, is an excellent overall performance material.
Characteristics of Layered CCAC Composites

- High electrical and thermal conductivity;
- Excellent soldering and electroplating properties;
- Highly malleable, easy to fabricate;
- Provides classic appearance;
- High intensity and light weight;
- Bimetal layers are metallically joined by passing through hot-rolling & deformation;
- Sufficiently malleable to permit fabrication such as forming and deep drawing;
- Tempers are available from “annealed soft” to “hard”.

Solid Phase Bonding
Methods to Produce CCAC

Three producing categories:

Solid-solid phase (SSP);
Liquid-Solid phase (LSP);
Liquid-liquid phase (LLP).

** The SSP includes the methods of explosion, extrusion, explore welding and hot rolling, rolling, diffusion, diffusion and welding, isothermal, and so on.
** The LSP includes the methods of casting, reversed solidification, jet plating, braze welding, casting-rolling, and so on.
** The LLP is the electromagnetic continues casting.
Importance of Efficiency Processing CCAC

Development of a suitable and quality CCAC fabrication process of which characterized as high efficiency, low energy consumption and short flow for scaled industrial production to provide alternative material and product to the rapid growth industries of electronics, electrical, metallurgy, machinery, automobile, energy, aeronautics and aerospace, to generate significant economic benefits due to the rational of utilization of resources, it ensures economic and social benefits on energy-saving, environmental reservation and sustainable development.
KEY to CCAC

The key to copper clad aluminum composite:

• Bimetal interface has formed the solid and reliable metallurgical bonding;

• Consistency and uniformity of cladding and core layer after rolling deformation;

• Good mechanical ductility and formability.
Applied Composite Material ("ACM") commits to research and development of new metallic composites as well as modern manufacturing process, fabricates various specification of high quality copper clad aluminum composites ("CCAC") in global market.

ACM factory is equipped with world-class, scaled and patented facilities of short-flow, continuous and automation processing of CCAC busbars, CCAC wires, CCAC wires, CCAC tubes and profiles.
The invented CCAC fabrication-flow starts by raw material online treatment, → flawless core layer preparation, → isothermal cladding and rolling, → online annealing and modification, → surface finishing and protective coating, → online inspection and cutting to length, → automatic collection, → robotic packing and packaging.

The CCAC fabrication system is characterized as solid-state, isothermal, short-flow, automation, high efficiency, low energy consumption and continuous processing.
Fundamental Character of CCAC Bus

Physical character of CCAC bus:

* CCAC Interfacial Share Strength > 80 MPa (Industrial Standard > 30 MPa)

* CCAC Bus Bar Tensile Strength > 110 MPa (Industrial Standard > 90 MPa)

* CCAC Bus Bar Elongation > 18% (Industrial Standard > 8%)
Shear Strength Test

Prepared Sample for Test
(Prior to Shear Strength Test)
Shear Strength Test

Prepared Sample for Test
(Prior to Shear Strength Test)
Interfacial Shear Strength Test (Pull-off)

Aluminum section is broken along with serious deformation after pull-off, the bimetallic interface remains unchanged.
Shear Strength Test

Interfacial Shear Strength Test
(Pull-off)

Copper section is broken along with serious deformation of aluminum after pull-off, the bimetallic interface remains unchanged.
Specification of CCAC Bus

* Copper layer cross-sectional ratio: 15%~30%;

* Copper layer mass ratio: 30%~60%;

* Coating layer uniformity: the thinnest layer > 90% of average copper layer in thickness;

* Straightness deviation $\leq 0.15\%$;

* Tolerance: width $\pm 0.3\text{mm}$, thickness $\pm 0.05\text{mm}$.

CCAC Application: Airbus 380
Specification of CCAC Bus

* Sectional shape: both sides are rounded, $R=1/2$ thickness; the top and bottom side are flat;

* Temper: from soft or hard;

* Surface: fine polished, no visible defects;

* Shipping condition: antioxidant coated, wrapped with thin insulating plastic film.

* Anti-oxidation life under normal temperature is great than 180 days.
## Current-Carrying-Capacity of CCAC Bus

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## Copper vs. CCAC, Comparison of Equal Current-Carrying-Capacity

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<th>Copper Bus</th>
<th>CCAC Bus</th>
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<th>Apecification (a×b) mm</th>
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The wide usage and special property of CCAC promote rapid development of CCAC applications, such as:

* Various CCAC wires,
* CCAC Panels & Sheets;
* CCAC bus-bars;
* CCAC precision tubes with inner-grooved threads;
* CCAC special purpose tubes.

* CCAC Joints;
* CCAC strips;
* CCAC Profiles;
CCAC Wires

CCAC wire has been used in high-frequency transmission application with advantages:

1. Low density, used as inner conductor of RF cable, easy to transport and installation;

2. Copper to aluminum cross-sectional ratio is 15% to 85%, great saving on copper;

3. When use as CATV coaxial cable inner conductor, the outer conductor is aluminum tube, the coefficient of thermal expansion is close to each other which thereby increase stability and reliability of the cable;

4. By comparison to copper as the inner conductor of signal transmission, due to high-frequency signal transmission and "skin effect", only small difference in performance.
CCAC Connector/Joints

CCAC connector is widely used in petrochemical, electrical and refrigeration industries, due to its excellent mechanical and electrical properties and overall performance.

The CCAC transitional joint is used in electrical engineering, refrigeration, heating equipment and various application fields such as transformers joint, cathode crimper, DTL fitting, casting-type transition joint, refrigerator and solar acceptance device.
CCAC Panels & Strips

CCAC panel and strip are widely used in automobile, motorcycle, television and electronic components featured with small thermal resistance, good heat dissipation and electromagnetic shield.

As the heat collector component of high quality and high performance solar heater, it is characterized by excellent thermal performance and efficiency, long life, good pressure and corrosion resistance.
CCAC busbar is replacing copper busbar for electrode of electrical equipment, building electricity transmission.
CCAC Flat Wires

CCAC flat-wire is replacing copper flat-wire for electrical winding coil equipment, it voids the cooked surface, arcing, overheat, reduces power consumption, ensures conductive property stable and extends life, has significant economic and practical prospects.
Various CCAC Tubes

CCAC tube, due to the unique three-layer structure, the strength of anti-vibration fatigue is twice as copper along with superior anti-blast capability, is used in special purpose industries and refrigeration equipments. Since the core layer of aluminum alloy is relatively soft compared to copper, the CCAC tube achieves better heat preservation effect and seal than copper tube while connects to a valve or other connecting tube, it is suitable for manufacture of air conditioning exhausting pipe, returning pipe, evaporator due to excellent heat exchange, and is used especially in aerospace, defense and other industrial applications.
Continuous & Short-flow Automation Processing

Online automatic packing and packaging devices
Continuous & Short-flow Automation Processing

Production coding and testing samples
Continuous & Short-flow Automation Processing

Finished products in warehouse
Continuous & Short-flow Automation Processing

Online plastic file wrapping and product collection devices
Continuous & Short-flow Automation Processing

Online automatic packing and packaging devices
The busbar together with trunking system is widely used in buildings and stadiums for electricity transmission.
Applications

Widely used as electrode, grounding terminator and wire for switchgear
Applications

Widely used as electrode, grounding terminator and wire for switchgear
Applications

Widely used as the thermal and electrical conductor in switchgear, aeronautics and aerospace
Applications

Widely used as the thermal and electrical conductor in buildings, Subway, cable train and ship
THANK YOU!

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