IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

A Method for Producing High Performance Cryorolled Ultrafine Grained Bimetallic Composite Sheets

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Bimetals**, particularly **Al/Cu bimetals**, are widely used in various industries due to their hybrid properties. They are particularly popular in **electrical components like cables and connectors.**
- Traditional **manufacturing methods like diffusion bonding**, roll bonding, explosive welding, and ultrasonic welding are suitable for Al/Cu bimetallic joining. However, intermetallic formation in these processes can **reduce electrical conductivity and properties**.
- **Roll bonding** is the most popular technique for producing Al/Cu bimetallic sheets due to its ease of use and process flexibility.
- A **new, technologically advanced manufacturing route is needed** to achieve superior interface, **ultra-high bond strength, and excellent mechanical properties.**

TECHNOLOGY CATEGORY/ MARKET

Technology: Cryorolled Ultrafine Grained Bimetallic Composite Sheets
Category: Advanced materials
Industry: Electronic System & Design Manufacturing (ESDM)
Application: Electrical and Electronics Industries.
Market: The global market size of projected to grow from **USD 6.67 billion in 2018 to USD 12.17** billion by **2027, at a CAGR of 6.92%.**

INTELLECTUAL PROPERTY

IITM IDF Ref. 2492
Patent No: IN 528430

TRL (Technology Readiness Level)

TRL-4, Experimentally validated in Lab;

Research Lab

Prof. Sushanta Kumar Panigrahi,
Dept. of Mechanical Engineering.

TECHNOLOGY

METHOD

1. The method comprising **partitioning at least one aluminium plate and at least one copper plate** with predetermined thicknesses and machined to the desired size
2. Subjecting the aluminium and copper plates to homogenization through a **heat treatment process**
3. Subjecting the aluminium and copper plates to **cryogenic-soaking process** to for a predefined time period
4. Subjecting the aluminium and copper plates to **multi-pass cryorolling with thickness reduction** to develop cryorolled aluminium and copper sheets
5. Subjecting the cryorolled copper sheet to **a short thermal treatment followed by water quenching**
6. Performing **surface preparation on the cryorolled aluminium sheet** and copper sheet involving at least one of **drilling, degreasing, scratch brushing and riveting**
7. Subjecting surface prepared sheets to **roll bonding with a thickness reduction to develop ultrafine grained aluminium/copper bimetallic sheets**
8. Subjecting the **ultrafine grained aluminium/copper bimetallic sheets to asymmetrical rolling**
9. Subjecting the **asymmetrically rolled ultrafine grained aluminium/copper bimetallic sheets to heat treatment for a short period of time to produce high performance cryorolled ultrafine grained bimetallic composite sheets**

CONTACT US
Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

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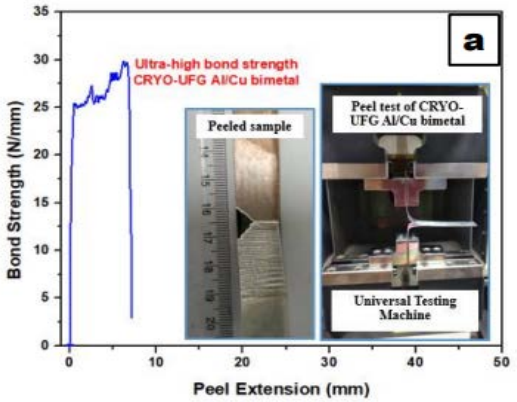


Fig 1 shows a bond strength vs peel extension, plots of CRYO-UFG Al/Cu bimetallic composite sheets

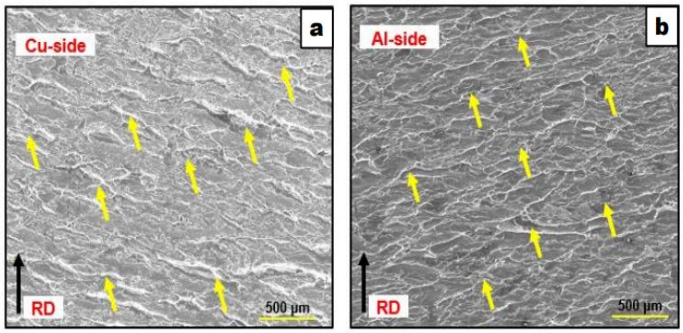
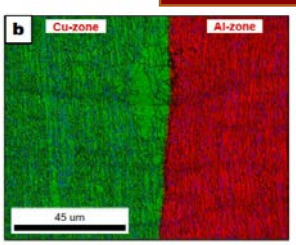


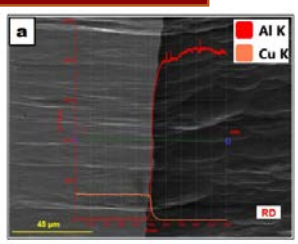
Fig 2 shows a Scanning Electron Microscope (SEM) magnification fractography of peel tested CRYO-UFG Al/Cu

Key Features / Value Proposition

- **Temperature**
  - ✓ Cryorolling is performed at a very low of approximately minus **(-) 196°C.**
- **Soaking**
  - ✓ The aluminium and copper plates in liquid nitrogen for minimum **15 mins before each pass.**
- A **2-High rolling mill**
  - ✓ Approximately **125 mm roll diameters** and the **rolling is carried out** at approximately **6 to 8 rpm.**
- **Thickness reduction**
  - ✓ **80% during multi-pass** cryorolling with an average grain size of **approximately 1 µm**
- **Short thermal treatment**
  - ✓ **250°C to 450°C** for a time period of 5 to 15 minutes.
- **Roll bonding**
  - ✓ a thickness reduction range of **approximately 55 to 60%.**
- **Roll Spec**
  - ✓ Roller **diameter 300 mm**
  - ✓ Rolling **speed 4-6 rpm** and
  - ✓ Rolling **load 30-45 tons**
- **Speed ratio**
  - ✓ Approximately **1.1 to 1.5 on a 2-high rolling.**
- **Bond strength**
  - ✓ Approximately 24 to 28 N/mm and
- Excellent **strength-ductility** synergy
  - ✓ (tensile strength of approximately **200MPa** and
- Total **ductility** of **(35 to 40%)** approximately .

SEM Images





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sm-marketing@imail.iitm.ac.in

Phone: +91-44-2257 9756/ 9719