

How to Cite:

Sundravalli, S., Vaggar, M. G., & Christurajan, M. (2022). A study on electrical resistance and RSW characterizaton of bimetal wire. *International Journal of Health Sciences*, 6(S5), 3774–3778.
<https://doi.org/10.53730/ijhs.v6nS5.9410>

A study on electrical resistance and RSW characterizaton of bimetal wire

Dr. Sundravalli

Professor, Department of Mechanical Engineering, Dhanalakshmi Srinivasan College of Engineering and Technology, Mamallapuram

Dr. Mallikarjun G Vaggar

Professor, Department of Aeronauticall Engineering, Dhanalakshmi Srinivasan College of Engineering and Technology, Mamallapuram

M. Christurajan

Assistant Professor, Department of Mechanical Engineering, Dhanalakshmi Srinivasan College of Engineering and Technology, Mamallapuram

Abstract---The objective of this study is to reduce copper consumption in Solenoid of Circuit breaker by using aluminium with copper technically called copper clad aluminium. Aluminium wires with copper clad are widely used, e.g. in telecommunication, power engineering, electronics as a replacement of traditional applied copper wire. The reason is that the properties of these bimetal wires combine the smaller density and low cost. This study investigates the effect of tripping properties in Circuit breaker thru various magnetic testing methods. Magnetic testing and an experiment verified the tripping threshold depends on the Copper and aluminium combination ratio.

Keywords---Copper Clad Aluminum wire (CCA), Solenoid made with Bimetal wire, magnetic testing.

1. Introduction

A miniature circuit breaker (MCB) is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. There are two elements inside MCB called, Thermal Sub assembly and Magnetic Sub assembly. Over current fault detects and interrupt electrical continuity by Thermal sub assembly, Short circuit fault detects and interrupt electrical continuity by Magnetic sub assembly. Magnetic sub assembly consists Solenoid (electromagnet) unit, while current increases beyond the rating it pull and releases the latch which then

allows the contacts to open by spring action. Unlike a fuse, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

Material Change

There are more difficulties in using clad wire, which are combination of different materials, than in using single phase wires due to their different material characteristics. To use such kinds of wires, therefore, it is important to ensure the resistance of the electrical properties. Copper clad wire is largely being used in the electric–electronic field, e.g. power cables, telecommunications and lead wires in electronic components because of smaller density, lighter mass and low cost as compare to bare copper. There are several ways to prepare the Copper clad aluminium composite: Plating aluminium wire with copper, coated welding, roll extrusion, hydrostatic extrusion, continuous extrusion and Assembly of CCA wire (fabrication). For this study we choose assembly method as copper as tube and aluminium as solid and assembled together and annealed subsequently to bring good bonding property of copper and aluminium.

2. Process

Bimetal wire making

First we made copper tube, size of 3.4mm outer diameter and 2.4mm inner diameter from hot extruded copper tube, size is 60mm OD and 40mm ID. The following steps are done for size reduction.

- 1) ETP copper billets were feed into hot chamfer and let it be molten stage with temperature of 1100 degree Celsius.
- 2) The molten copper push into die of 60/40 (standard size) to make Copper tube extrusion with controlled temperature.
- 3) Water coolant method used for reduce the temp of output.
- 4) After a day, the bulk copper tube (60/40) moved to wire drawing for size reduction.
- 5) Bulk reduction from 60/40 to 30/20 by ten passes, after that annealing process done by using Nitrogen chamfer.
- 6) Further reduction taken from 30/20 to 3.4/2.4 by 22 passes with multistage annealing to maintain wire properties.

By using CCA wire, solenoid coil fabricated and made as coil form with designed angle which is related to welding with other parts. The coil form done by manually with hand tools and ensured the drawing dimensions.

2.3 Welding with other parts

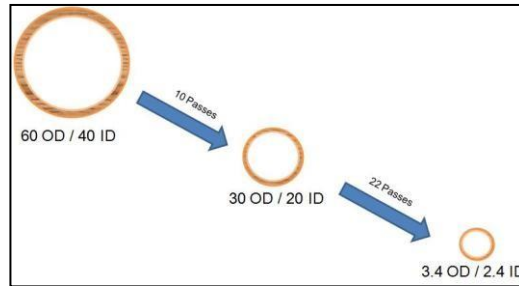


Fig.1 Copper tube size reduction

Next stage is assembling two materials and done drawing and annealing processes to get bimetallic wire. The Following steps are done

- 1) Before assemble wire and tube cleaned with tri-chloro-ethylene chemical to remove handling contamination on the surfaces
- 2) After dried, aluminium wire inserted into copper tube by manually.
- 3) Without size reduction, preliminary drawn done to ensure assembly before feed into annealing process.
- 4) Once manual assembly over, the assemble CCA material kept in Nitrogen chamfer with 400 degree Celsius for 2 hours.
- 5) Annealed CCA wire taken to wire drawn process to reduce size gradually from 3.4mm to 3.0mm with intermediate annealing process.

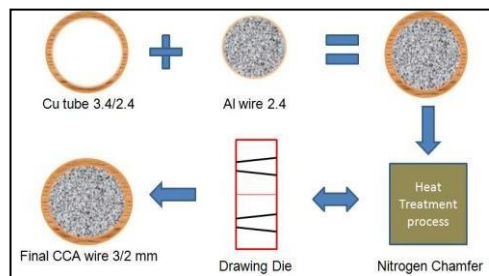


Fig. 2 CCA Wire assembly and Draw

Solenoid coil fabrication

Bimetallic (CCA) coil was undergone resistance spot welding (RSW) process to weld with other solenoid parts to become magnetic solenoid of MCB. The process outline and other parts material details are given below

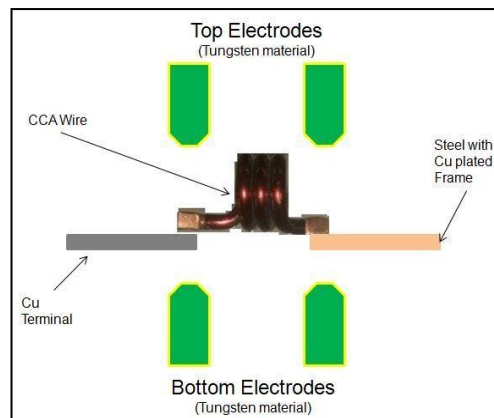


Fig.3 Spot welding Process

Here we tested welding strength of bimetal wire and ensured contact should not open when high thermal conductance.

3. Testing

Once the solenoid assembly ready (made up of CCA coil), then it will assemble with other sub assemblies become Miniature Circuit Breaker (MCB).

Following tests are conducted and analysed the magnetic tripping of CCA wire.

- 1) Di-Electric process
- 2) Magnetic Threshold test
- 3) Temperature Rise test
- 4) Electrical endurance
- 5) Short Circuit test.

4. Results

Following tests are conducted so far and found no abnormalities as functionally

- 1) **Di-Electric test** – Apply 500V between terminals/connectors and measured the leakage after ensured no leakage thru this CCA wire.
- 2) **Magnetic Threshold** – As per IEC60898 standard, applied 5 to 10IN (rated current) and measured the tripping property of CCA wire.
- 3) In that we found the tripping is not mean position and we reduced the solenoid spring from 335grams to 235 grams springs. Again conducted 5 to 10IN test and brought tripping property to mean position
- 4) **Temperature Rise test** - While doing magnetic tripping test, we measured temperature at CCA solenoid area and found more heat than regular coil. Further study is going on this area.

5. Conclusion

Based on the above test results CCA wire can be used in Circuit Breaker solenoid assembly as magnetic coil, but ensures the thermal property which is come to satisfactory level. Another factor is cost; when we go for bimetallic wire, process cost need to work-out and make sure it suppose to viable and need to plan for scrap materials handling.

6. References

- (1) Rhee K Y, Han W Y, Park H J, Kim S S. Fabrication of aluminum/copper clad composite using hot hydrostatic extrusion process and its material characteristics [J]. *Materials Science and Engineering A*, 2004, 384(1/2): 70-76.
- (2) Luo Jun-ting, Xu Yan, Zhao Shuang-jing. Cold extrusion forming of copper/aluminium clad composite [J]. *International Journal of Applied Mechanics and Materials*, 2009, 16/17/18/19: 441-444.
- (3) Xu Yan, Luo Jun-ting, Jia Jian-bo. Study on the fabrication of Aluminum/copper clad composite by low- pressure compression casting-cold extrusion technology [J]. *China Mechanical Engineering*, 2009, 20(22): 2755-2758. (in Chinese)
- (4) Rinaritha, K., Suryasa, W., & Kartika, L. G. S. (2018). Comparative Analysis of String Similarity on Dynamic Query Suggestions. In 2018 Electrical Power, Electronics, Communications, Controls and Informatics Seminar (EECCIS) (pp. 399-404). IEEE.
- (5) Xu S, Zhao G, Ren G, Ma X. Numerical simulation and experimental investigation of pure copper deformation behaviour for equal channel angular pressing/extrusion process [J]. *Computational Materials Science*, 2008, 44(2): 247-252.
- (6) Rahma, D. Y., & Atmaja, M. H. S. (2022). Peritoneal carcinomatosis and mimicking on CT scan findings. *International Journal of Health & Medical Sciences*, 5(1), 154-162. <https://doi.org/10.21744/ijhms.v5n1.1864>
- (7) Narayaasamy R, Ramesh T, Pandey K S. Some aspects on strain hardening behaviour in three dimensions of aluminium-iron powder metallurgy composite during cold upsetting [J]. *Materials & Design*, 2006,