

## Copper-clad aluminum as an alternative to copper flexible conductors for electric power cables: opportunities and challenges

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### ABSTRACT

*The majority of flexible conductors for LV power cables is today made with Copper. Use of alternative metals for these cables is investigated, under the push of significant cost reduction. Aluminum is an alternative but some technical concerns are considered in terms of mechanical and corrosion resistance properties. Bimetallic conductors like copper-clad aluminium can combine advantages of the 2 metals, with attractive cost. LV flexible cables were produced with Cu, CCA, tinned CCA and Al class 5 conductors; CCA conductors were evaluated in terms of quality and integrity of copper layer; an evaluation of main cable properties was considered.*

### KEYWORDS

Cu, CCA, copper-clad aluminium, aluminum, flexible conductors, class 5 conductors, LV cables.

### INTRODUCTION

The pressure of high copper prices during the last decade requires innovative solutions to reduce its strong impact on material costs for wire and cable (W&C). Aluminum is a well-known material for producing conductors with a good cost/performance ratio (conductive and lightweight) that has been used for many years. Nowadays, copper is still largely used in W&C and its replacement with aluminum presents challenges for various reasons: a larger diameter of aluminum is required to match the resistance of a copper conductor, aluminum's mechanical properties (tensile strength) are inferior to those of copper, aluminum presents processing difficulty in fine wires (i.e. drawing to <0.5mm diameter), and aluminum offers poor corrosion resistance.

Bimetallic conductors like copper-clad aluminum (CCA) offer interesting key features for niches of cables where aluminum is not a viable choice versus copper. Several grades of bimetallic conductors are available on the market, but not all of them are adequate for applications in the electric cable industry. In this sense, the manufacturing technology can seriously affect quality: cladding is strongly preferable to electroplating.

The objective of this work is to evaluate metals like aluminum, CCA and tinned CCA as alternatives to copper for flexible conductors in building wires and LV power cables. Cables have been designed with conductors having the same DC resistance. Prototype cables were manufactured and characterized according to the

specifications required for copper cables used in the application. Additional tests were carried out to simulate aggressive environmental conditions with heating thermal cycles.

Special focus is given to the definition of high-quality CCA and its related characteristics. Special tests are described in order to select material with resistance to corrosion similar to that of copper.

High-quality CCA conductors, as produced according to Copperweld technology (Copperlite™ CCA) in combination with the use of selected raw materials, show process characteristics close to those of copper, especially when it is drawn to fine diameters (i.e. multi-wire 8x0.25mm) as required for flexible cables. The strong metallurgical bond between the aluminum and copper obtained with Copperlite™ CCA enables the drawing of fine wires (i.e. down to 0.20 mm diameter at 20m/sec production speed, in conventional copper drawing equipment) with no impact on the Al/Cu volume ratio and maintains a strong bond at the interface between the two metals

Prototype cables manufactured with high-quality CCA conductors showed performance comparable to that of copper, even in severe high-humidity conditions, whereas aluminum conductor cables failed.

### ALTERNATIVE METALS TO SUBSTITUTE COPPER AS FLEXIBLE CONDUCTORS FOR LV CABLES : AL AND CCA

Copper has been predominantly used in power cable applications as it provides the best conductivity for the best price as compared to silver or gold. Increasing copper price and copper theft lead to the search for a cost saving and theft deterrent product. Aluminum has been investigated and used in LV and MV power cable applications as a cost saving alternative. Cables such as building wire, service drop, parallel aerial cable, secondary UD cable, and 600 V power cables can be manufactured using aluminum and are available commercially in the US market. Even though aluminum has been widely used in US market, there are still significant concerns in special applications due to its oxidation and creep phenomena. Two people died in a house fire due to an overheated aluminum wire connection at a wall receptacle [1].