» New Products

The Wiring Harness Composed of Aluminum Electric Wires for an Automobile Seat

1. INTRODUCTION

The automotive industry is now in the middle of a revolution period once in a hundred years, and the technological innovation is in a great progress especially in the field of so-called “CASE”, that is, Connected, Autonomous, Shared & Service and Electric.

The increase of the automotive equipment and its electronization are further accelerated by these technological innovations and, as a result, this increase is also increasing the weight of vehicles. Solutions for the weight-reduction of vehicles are necessary under the circumstance where the improvement of the fuel efficiency and the reduction of the CO_2 emission are highly required. Accompanied with the increase of the automotive equipment and its electronization, the number of circuits in the wire harness (W/H), which supplied electric power and control signals to each electric and electronic equipment in a vehicle has been increasing, and the weight-reduction through replacing conventional copper electric wires to aluminum electric wires has been in progress.

Recently, along with the increasing equipment in a vehicle, many circuits have been included in the W/H installed in the seat as well. On the other hand, an automobile seat was used under a severe environment where various solutions were supposed to stick such as seat cleaner and a deodorizer, even though it was located in a cabin. Therefore, such a risk as any connecting portion of the aluminum electric wire might be corroded made the replacement of the aluminum electric wire more difficult than in other W/H.

Accordingly, aiming at combining the weight-reduction with a high reliability, we have applied our “α terminals” shown in Figure 1, which had a high reliability protected with its hermetically sealed structure even under the environment where various solutions might stick and have realized a seat W/H composed of aluminum electric wires, which have never been installed in any automobile seat before.

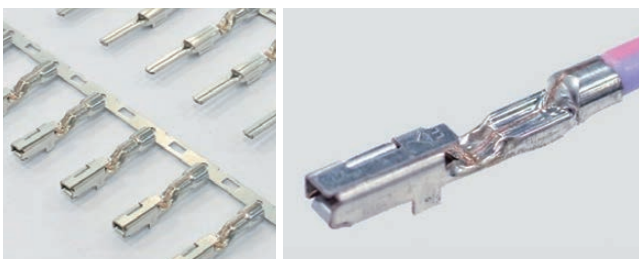

Figure 1 Corrosion-proof terminals for aluminum wires, “α terminal” series.

2. COMPONENTS FOR THE W/H AND PROBLEMS TO ADOPT ALUMIMUM ELECTRIC WIRES

W/H is a product constructed from various components such as electric wires, terminals, connectors, exterior components and others. As illustrated in Figure 2 for example, the weight of copper electric wires used in a conventional W/H for an automobile seat generally amounts to approximately 50% to 70% of the whole weight of the W/H. In this development to use aluminum electric wires instead of copper electric wires for an automobile seat W/H, we have accomplished a drastic weight-reduction by replacing copper electric wires which amount to a large portion of the weight composition of the W/H with aluminum electric wires.

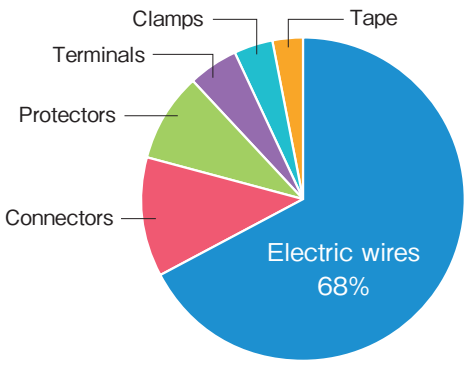

Figure 2 An example of a weight ratio of each component in a conventional seat W/H (composed of copper electric wires).

However, we had a problem of bimetallic corrosion (galvanic corrosion) when replacing copper electric wires used in a W/H with aluminum electric wires. A terminal crimped on the end of an electric wire in a W/H is generally made of either brass or copper alloy. The corrosion is produced when the contact interface of the terminal and the aluminum electric wire is exposed to water, oxygen, and an electrolyte.

Therefore, when replacing copper electric wires with aluminum electric wires, protective measures against the corrosion are necessary at the terminal connection portion of every circuit which may be exposed to water in order to secure a stable electric connection between different metals of an aluminum electric wire and a terminal (brass or copper alloy).

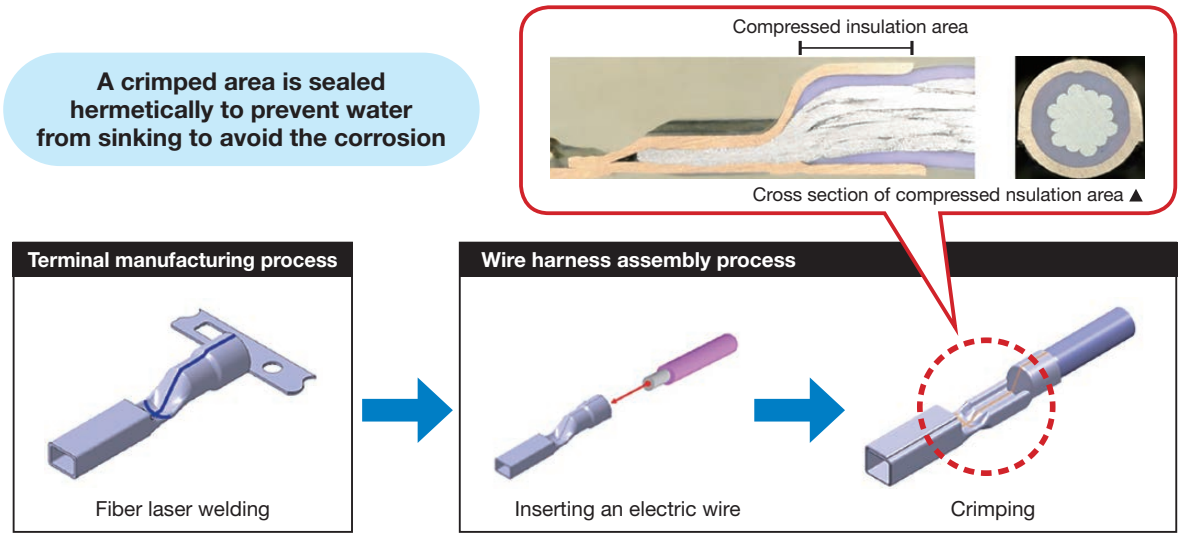

Figure 3 Sectional structure of the crimped terminal of "α terminal series" and its manufacturing and assembly process.

3. FEATURES OF α TERMINAL SERIES

A conventional treatment for the corrosion protection was to seal the whole crimped portion with a resin to avoid any contact between the aluminum conductor and the terminal against a solution. However, it has hardly spread in general because of several problems such that any cavity of an existing connector housing was too small to accept the terminal whose crimped portion was enlarged with the sealing resin and that the production cost became higher for the equipment and for the man-hour required to apply the individual product treatment.

Then, we have developed the anti-corrosion terminal for aluminum electric wires "α terminal series" as an innovative method for the corrosion protection. It has realized an excellent anti-corrosion performance protected by an airtight tubular structure as shown in Figure 3 and also a high productivity and a low cost by completing the electrical connection and the anti-corrosion treatment at the same time. "α terminal series" have been contributing in expanding the aluminum electric wires in the automotive W/H, as "α terminal series" were adopted to LAND CRUISER series from the 2015 year model, and have been producing actual results that not only more than 400 million pins were already implemented vehicles in the market but also no failures were reported in the market[1].

4. REPLACING COPPER ELECTRIC WIRES WITH ALUMINUM ELECTRIC WIRES IN THE W/H OF AN AUTOMOBILE SEAT

Until today, we have been promoting the replacement to the aluminum electric wire in the W/H installed in a body or a floor of vehicles supported by adopting our "α terminal series". On the other hand, as mentioned above in Chapter 1, the environment in the W/H for an automobile seat, where various solutions were supposed to stick such as seat cleaner, disinfectant cleaner and a deodorizer was quite severe against the aluminum electric wire. Therefore, the replacement to the aluminum electric wire was more difficult than in the other W/H. Further, when adopting the aluminum wire in such an environment, a very high anti-corrosion performance is necessary at all the connecting areas.

Accordingly, we proposed our solution to our customer over and over to solve the reliability problem by applying our "α terminal series" and asked our customer to give us criteria of the anti-corrosion performance required for an automobile seat. We have carried out the anti-corrosion performance test of our "α terminal series" against as many as 90 solutions which were supposed to stick, and have confirmed that our "α terminal series" had a high anti-corrosion performance to secure the connection reliability without any increase of its electric resistance as a result. Further, we have earned more trust from our customer as a result of these actual test data, and have established our "α terminal series" as a de facto standard for the anti-corrosion method of a seat W/H.

Figure 4 Wire harness for an automobile seat.

As a result, the seat W/H composed of aluminum electric wires to which our "α terminal series" were applied was adopted to the seat made by Toyota Boshoku assembled in a new model of Land Cruiser 300 launched in August, 2022. And it was the first seat W/H composed of aluminum electric wires. 115 circuits out of 152 circuits of the seat W/H for the automobile were replaced with aluminum electric wires (the aluminum electric wire rate: 75%) and the weight of electric wires was reduced by 44% (approximately 200 g). As a matter of course, our "α terminal series" were applied to all the circuits replaced with aluminum electric wires.

5. CONCLUSION

We have accomplished the weight-reduction of the seat W/H developed this time by replacing overall copper electric wires with aluminum electric wires by as much as 44% of its weight of electric wires in comparison with the W/H composed with copper electric wires.

In the future, the weight of a seat W/H is expected to increase further because more and more high-performance equipment will be mounted on an automobile seat. And our continuous efforts will be required in solving the environmental problems for the future as well. We are expanding the application of aluminum electric wires further to an automotive W/H by applying our "α terminal series" to promote the weight-reduction of automobiles and the improvement of environmental performance, and we will continue to contribute to realize the carbon-neutral society.

REFERENCE

1) Takanori Toyama, Kouhei Ikemoto et al.: "Development of the Wiring System Technology to Realize its Weight-Reduction in Vehicles", Furukawa Electric Review No.53, 2022.

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