

Aluminum Wire Harness

1. INTRODUCTION

In the automobile industry, demand for weight reduction of the parts has been extremely strong because environmental awareness has been increasing in recent years. At the same time, there have been constant concerns for the resource depletion and the sudden rise in the price of copper, which is a conductor material for the existing wire harness. Therefore, search for an alternate material to copper is one of the great challenges for wire harness manufacturers.

We focused attention on aluminum because of its light-weight, its moderate price and its abundance. We have advanced in the development of an aluminum wire using aluminum alloy as a conductor material and in the peripheral technology to apply the aluminum wire to a wire harness.

We have just completed the development of an installation technology of a wire harness using aluminum wires (aluminum wire harness) to automobiles. It has already been decided to be installed in a mass-production automobile from 2012. In this mass-production automobile, its backdoor harness trimmed weight to about 15% by adopting the aluminum wires.

2. COMPOSITION

A wire harness is a product manufactured by combining various component parts such as wires, terminals, connectors and a protector. As shown in Figure 1, the wire weight accounts to about 60 - 70% of the gross weight in general.

The aluminum wire harness significantly reduces weight by substituting its wire from the existing copper wire to the aluminum wire.

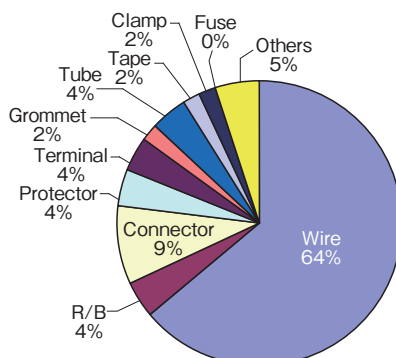


Figure 1 Weight ratio of wire harness per component part.

3. PROPERTIES

To adopt an aluminum wire, developments of both the wire itself and its peripheral technology are important. We will explain the three prime properties in these technologies: “the alloy material used for the wire conductor”, “aluminum wire connection technology” and “the countermeasures for galvanic corrosion in the terminal part”.

3.1 Alloy Material Used for the Wire Conductor

We have developed a 1000 system aluminum by slightly adding Fe, Cu and Mg to aluminum. This alloy material is a Furukawa Electric’s own alloy called MS2AL that fulfills the five capabilities required for the wire harness in a good balance: conductivity rate, jointing property, mechanical strength, flexibility and bending ability.

3.2 Aluminum Wire Connection Technology

To ensure the stable performance of aluminum wire electrical connection, we have developed a terminal for small size aluminum wires that have equal to or less than 2.5 sq of cross sectional area. Aluminum wires have strong oxide films on its surfaces and the following issues are important for an excellent electrical connection. They are the dent made to the wire barrel by crimping the terminal, the wire elongation caused by the strong compression and the wire penetration into grooves formed at the wire connection part, called serration, of the terminal.

The terminal for the aluminum wire is designed to remove the oxide film effectively. The wire barrel deployment length is optimized for wire diameter and the terminal is shaped to have approximately 60 % of wire compression ratio, furthermore edge part is increased by changing the serration shape.

This terminal for aluminum wires makes the electrical performance and the mechanical strength compatible as shown in Figure 2, and guarantees an excellent connection performance, which could not be obtained with traditional terminals.

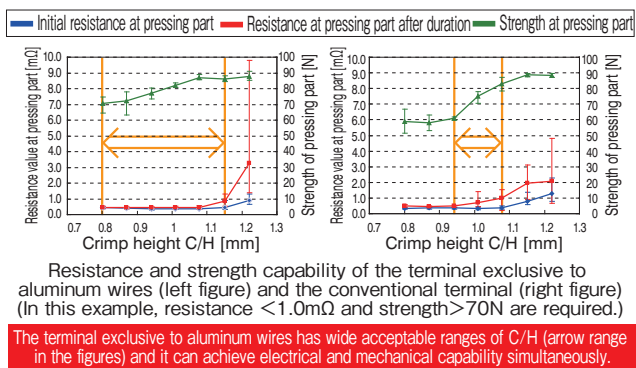


Figure 2 Connecting property of the terminal for aluminum wire.

Because of the oxide film of the aluminum wire, an unstable electrical connection was the problem in case of large size cables with large number of strands. Therefore, we decided to adopt the pre-processing for wires larger than 2.5 sq to connect the tips of wires with an ultrasonic solder or an ultrasonic welding shown in Figure 3. By crimping the welded wires, even large size wires can be electrically connected effectively.



Figure 3 Ultrasonic soldered aluminum wire and crimping.

3.3 Countermeasures for Galvanic Corrosion in the Terminal Part

Terminals for the terminal part of a wire harness generally use brass or copper alloys. This raises a concern that galvanic corrosion occurs in the connection area of the aluminum wire and the terminal depending on the external environment.

In an automobile environment installation, the aluminum wire, which is adopted to the part which has a galvanic corrosion concern, needs an anti-corrosion treatment in the terminal part. For the anti-corrosion method, we have developed an environmental deprivation method which blocks the contact interface of the aluminum conductor and the copper terminal from outside using a resin material.

We have consolidated two kinds of anti-corrosion treatments based on the specs of our automaker customer. Figure 4 illustrates both, the molding method and the dropping method.

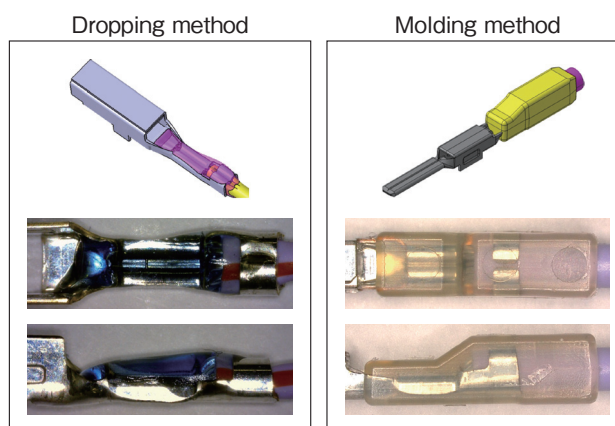


Figure 4 Anti-corrosion method.

4. LINEUP AND EFFECT OF WEIGHT REDUCTION

Currently, we have prepared the products of aluminum wires in sizes greater or equal to 0.75 sq as shown in Table 1. Their conductor standard is based on the ISO standards. A halogen-free material is used for the insulator. The allowable temperature limit is 80°C.

When substituting an aluminum wire to a copper wire, choosing the aluminum wire the next size larger than the copper wire is common because of the difference of electrical conductivity between copper and aluminum. Therefore, copper wires of greater or equal to 0.5 sq are the target wires to be substitute with the aluminum wires.

When a copper wire is substituted with the aluminum wire, about a reduction of 30 - 40% of the wire weight (depending on the size of the wire) can be achieved. Also, as a whole wire harness, about a reduction of 10 - 20% of weight (depending on the application or the extent of the implementation) can be achieved.

Table 1 Replacement of aluminum wire with copper wire.

Copper wire			Aluminum wire			Weight-saving effect %
Wire type	Nominal diameter	Mass (standard) g/m	Wire type	Nominal diameter	Mass (standard) g/m	
CHFUS	0.5	5.5	ALUS	0.75	3.1	▲43.6
CHFUS	0.75	7.7	ALUS	1.25	5.0	▲35.1
CHFUS	1.25	12.7	ALSS	2 f	9.1	▲28.3
HFSS	2 f	21.5	ALSS	2.5 f	11.7	▲45.6
			ALSS	3 f	13.6	▲36.7

5. FUTURE PLAN

We have completed the necessary technology development to commercialize the aluminum wire harness. In the future, increase of the percentage of the aluminum wires' implementation will be an important theme.

To raise the percentage of the aluminum wires' implementation, "reducing the cost of anti-corrosion" and "expanding the types of wires" (Figure 5) are necessary.

Because an anti-corrosion treatment is unnecessary for copper wires, its cost becomes a net increase by imple-

menting the aluminum wire. Keeping the net increase as small as possible accelerates the substitution to the aluminum wire.

Also, the current lineup only includes the general wires which are resistant at 80°C. Therefore, their adoption to the parts which require heat resistance and anti-bending ability is difficult. By expanding the types of wires such as a heat resistance wire, the implementation rate of the aluminum wires is expected to increase.

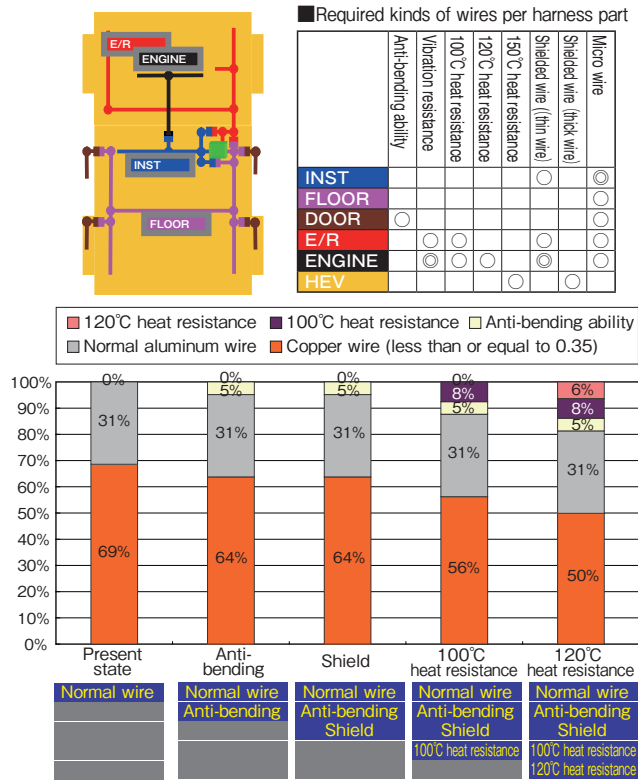


Figure 5 Prediction of aluminum wire adoption rate.

We are planning to continue the development of the technology with a focus on the two development themes above to achieve a weight reduction impact by using the aluminum wires to the maximum extent.

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