

New Chemical Cross-Linked Halogen-Free Insulated Wire “EcoacePlus Series”

1. INTRODUCTION

Halogen-free equipment wires are mainly used in the office equipment and home appliances industries, since they are environment-friendly containing no harmful substances in their insulation. Work is currently under way not only to reduce the targeted six substances but also to make a departure from PVC, aimed at the Restriction of the Use of Certain Hazardous Substances (RoHS) which is scheduled to come into force in July, 2006, while the demand for the wires are basically increasing.

Conventional halogen-free electric wires have adopted, as the base material, flame-resistant cross-linked polyolefin obtained by electron beam irradiation thereby satisfying both heat resistance and vertical flame resistance. These products, however, has the disadvantage that, when they are used for wiring under high stress, they are more susceptible to whitening of the surface due to abrasion than PVC. For this reason, use of halogen-free electric wires has been withheld by some customers and from some equipment.

Furukawa Electric has recently developed a new chemical cross-linking technology, and has commercialized “EcoacePlus Series” of new halogen-free electric wires for equipment wiring. By adding this product to our lineup, we plan to strengthen our capability of responding to the requirement of departure from PVC, and simultaneously, to expand the adoption of halogen-free electric wires.

Table 1 Specifications of EcoacePlus Series.

New halogen-free wire				PVC wire
Rated temp.	Rated voltage	Conventional	Grade name	
105°C	150 V	UL 3384	EcoacePlus -105	UL1007 (80°C, 300 V)
	300 V	UL 3385		UL1061 (105°C, 300 V)
		UL 10368		UL1015 (105°C, 600 V)
	600 V	UL 3386	EcoacePlus -105R	UL10272 (80°C, 150 V)
		UL 10369		UL1061 (80°C, 300 V)
	150 V	UL 3619		
300 V	UL 10368			

2. NEW CHEMICAL CROSS-LINKED MATERIAL

The cross-linking technology is generally used to prevent resins from melting at high temperatures, thereby improving the heat resistance. Conventionally cross-linking is effected through several methods including peroxide cross-linking in which peroxides are added followed by heat treatment; silane cross-linking in which silane couplers are added followed by hydrothermal reaction treatment; and electron beam cross-linking in which electron beams are irradiated onto the resin, and in all these technologies a cross-linking process has to follow an extrusion process.

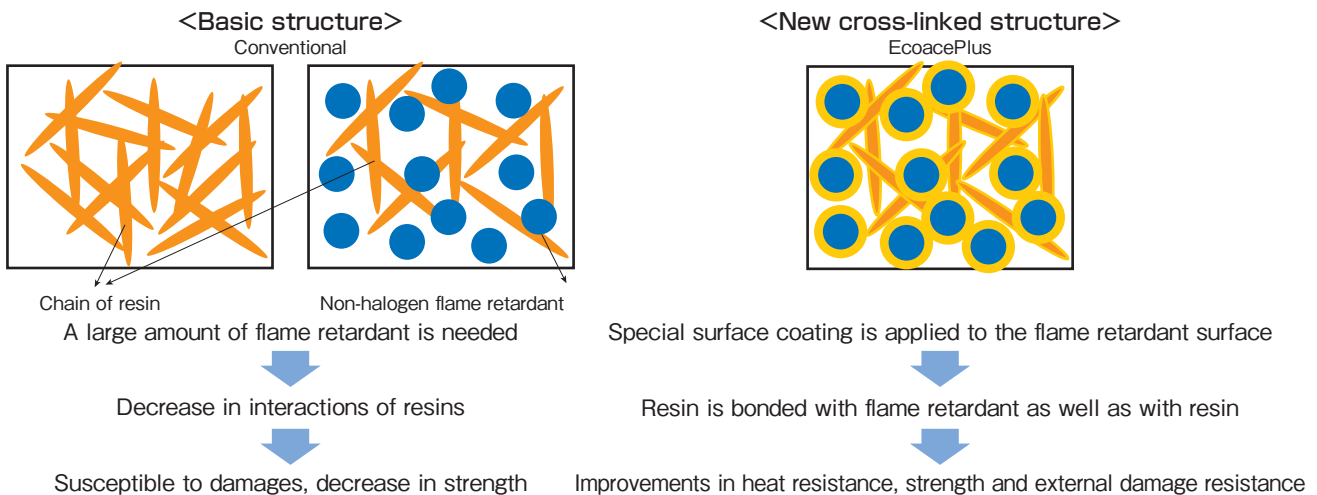


Figure 1 Comparison of cross-linking structures of EcoacePlus and conventional wires.

Using the new cross-linking technology, in contrast, resins are cross-linked at the time of kneading, and since the resins are in a moderately cross-linked state after kneading, it is possible to extrude the resins necessitating no cross-linking process after molding, and re-molding is permitted.

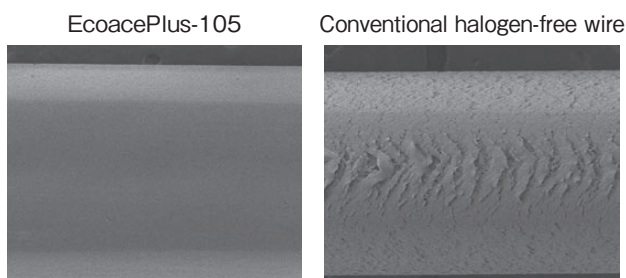
Furthermore, halogen-free insulation materials contain a large amount of flame retardant as well as base resin of polyolefin to achieve a high level of flame resistance. Focusing attention to this fact, we investigated surface treatment of the flame retardant together with cross-linking of the base resin, and succeeded in significantly improving the external damage resistance through binding the flame retardant with the base resin.

3. FEATURES OF NEW CHEMICAL CROSS-LINKED HALOGEN-FREE INSULATED WIRE "ECOACEPLUS SERIES"

Based on this technology, the base resin is firmly bonded with metal hydrate (i.e. flame retardant) to obtain a high degree of mechanical strength and external damage resistance. See Photo 1. Meanwhile, it has been confirmed that the new wire provides wire-end workability of the same level as conventional heat-resistant PVC electric wires in terms of pressure welding and crimping --- common wire-end processing methods for equipment electric wires. See Photo 2.

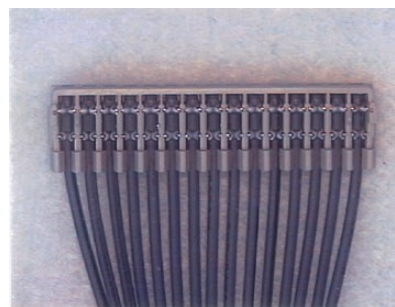
The main features are summarized below, and Table 2 shows the test results of general physical properties.

- Excellent external damage resistance
- Provided with vertical flame resistance
- Material recycling is possible
- Provided with wire-end workability of the same level as PVC electric wires
- Free from the six substances specified in the RoHS as well as halogens, phosphorous and antimony
- In compliance with UL standard and CSA standard

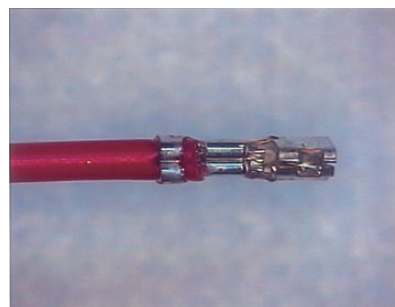


External damage test conditions: $r=0.125$ mm, load=800 g x 10 times

Photo 1 Photographs comparing the surface whitening of EcoacePlus and conventional wires. SEM images (x60).



Pressure welding (EcoacePlus-105R)



Crimping (EcoacePlus-105)

Photo 2 Wire ends of EcoacePlus.

Table 2 Characteristics of EcoacePlus Series.

Item		Test conditions (UL 758)	EcoacePlus -105	EcoacePlus -105R
Material property	Tensile strength	Tensile speed: 500 mm/min Gauge length: 25.4 mm	11.7 MPa	30.0 MPa
	Elongation		201%	185%
Aging characteristics	After aging tensile strength ratio	Aging condition: 136°C x 168 hr	108%	101%
	After aging elongation ratio		70%	60%
High-temperature winding	After winding 6 turns at 136°C x 1 hr Mandrel diameter: self-diameter x 2	No cracks found on the surface	No cracks found on the surface	
Low-temperature winding	Winding 6 turns at -10°C x 4 hr Mandrel diameter: self-diameter x 2	No cracks found on the surface	No cracks found on the surface	
Heat deformation	120°C x 1 hr Load: 2.45 N for insulation thickness less than 0.76 mm 3.92 N for insulation thickness not less than 0.76 mm	28%	5%	
Flame resistance	VW-1	Passed	Passed	

4. CONCLUSIONS

We have recently developed a new cross-linking technology, and have added to our product lineup EcoacePlus Series of significantly improved resistance against external damages. Through unification of substitution products for general heat-resistant PVC electric wires with a rated temperature of 105°C into EcoacePlus Series, we intend to expand the employment of halogen-free electric wires,

in conjunction with EcoBeamex Series for high-rated temperatures of 125°C and 150°C, in the marketplace of electric wires for electric equipment.

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