FIG. 5 is a schematic perspective view of a heat shrinkable connecting component according to another embodiment of the present disclosure.

FIG. 6 is a schematic view illustrating a state before conductors exposed from two insulated electrical wires are inserted into a heat shrinkable connecting component according to an embodiment of the present disclosure.

FIG. 7 is a schematic view illustrating a state in which a connection portion of two insulated electrical wires is covered by a heat shrinkable connecting component according to an embodiment of the present disclosure.

FIG. 8 is a schematic view illustrating a state where a heat shrinkable connecting component according to an embodiment of the present disclosure starts to shrink when heated.

FIG. 9 is a schematic view illustrating a state where a sealing material of a heat shrinkable connecting component according to an embodiment of the present disclosure is melted.

FIG. 10 is a schematic perspective view of a bundle of electrical wires connected by a heat shrinkable connecting component according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0008] [Problems to be Solved by Present Disclosure]

For a connecting component of insulated electrical wires, not only protection of a connecting portion of the insulated electrical wires but also prevention of water intrusion from the outside into the connecting portion and high sealing property so as to maintain insulation are required.

[0009] The present disclosure has been made in view of the above circumstances, and an object of the present disclosure is to provide a heat shrinkable connecting component which is excellent in sealing ability and durability under a high temperature environment as a connecting component for insulated electrical wires.

[0010] [Advantageous Effects of Present Disclosure]

According to the present disclosure, a heat shrinkable connecting component having excellent sealing ability and durability under a high temperature environment can be provided as a connecting component for insulated electrical wires.

[0011] [Description of Embodiments of Present Disclosure]

4.0 parts by mass with respect to 100 parts by mass of the resin in the sealing material, the shear viscosity of the sealing material at high temperatures of 250°C and 215°C can be adjusted to a good range, and thus the sealing property of the heat shrinkable connecting component can be further improved.

[0019] (6) In any one of (1) to (5), transmittance of infrared light having a wavelength of 1 μm in the sealing material may be 1.0% to 30.0%. When the transmittance of infrared light having a wavelength of 1 μm in the sealing material is within the above range, the infrared light absorptivity of the heat shrinkable connecting component in infrared light heating can be improved, and good heat shrinkage behavior of the heat shrinkable connecting component can be obtained. The measurement method of transmittance of infrared light having a wavelength of 1 μm can be measured by using a spectrophotometer UV-3600 manufactured by Shimadzu Corporation.

[0020] (7) In any one of (1) to (6), the heat shrinkable tube may further include a connection portion disposed at an inner peripheral surface of the heat shrinkable tube between the pair of sealing portions. A solder material of the connection portion may have a melting point of 210°C to 240°C. When the heat shrinkable tube further include a connection portion disposed on the inner peripheral surface between the pair of sealing portions, and the melting point of the solder material in the connection portion is in the above range, the heat shrinkable connecting component can have good connection of the insulated electrical wires.

[0021] (8) In any one of (1) to (7), arithmetic average roughness Ra of a surface of the heat shrinkable tube may be 0.10 μm to 2.00 μm. When the arithmetic average roughness Ra is 0.10 μm to 2.00 μm, the visibility of the inside of a heat shrinkable tube can be secured, and the infrared light (IR) absorptivity in infrared light heating during the manufacturing step of heat shrinkable tube can be improved. The "arithmetic average roughness Ra" means a value measured in accordance with JIS-B0601:2001 with a cut-off value (λc) of 2.5 mm and an evaluation length (l) of 8 mm.

[0022] (9) A method of manufacturing a heat shrinkable connecting component according to another aspect of the present disclosure includes disposing a pair of sealing portions at inner peripheral surfaces of a heat shrinkable tube at two end portions of the heat shrinkable tube. The disposing the sealing portions includes shrinking the heat shrinkable tube and fixing the sealing portions in place. The heat shrinkable tube has a

device, and thus the heating may be insufficient. On the other hand, the upper limit of the arithmetic average roughness Ra may be 2.00 μm or less, 1.50 μm, or 1.00 μm. When the arithmetic average roughness Ra of the surface of heat shrinkable tube 1 exceeds the upper limit, the scattering of visible light increases, and the visibility of the inside of heat shrinkable tube 1 decreases, and thus it may be difficult to check the degree of shrinkage of the heat shrinkable connecting component including heat shrinkable tube 1. In the heat shrinkable connecting component for the insulated electrical wires, visibility of the inside of heat shrinkable tube 1 is required in order to check a shrinkage state, melting of a solder material, a connection state of the electrical wires, and the like. Thus, the heat shrinkable tube used in the heat shrinkable connecting component is required to have transparency. In heat shrinkable tube 1, the arithmetic average roughness Ra is in the above range, whereby the visibility of the inside of heat shrinkable tube 1 can be secured, and the infrared light absorptivity in infrared light (IR) heating during the manufacturing step of heat shrinkable tube 1 can be improved.

[0035] [Connection Portion]

When connection portion 2 is made of solder, a metal-based material can be used as a solder material, and for example, any of Sn, Sb, Pb, Bi, Ag, Cu, Ni, In, Ge, P, and Zn can be used in combination. In addition, from the viewpoint of adjusting the melting point, Sn-Ag, Sn-Cu, Sn-Sb, Sn-Pb, and Pb-In may be contained. The solder material may include a flux.

[0036] In heat shrinkable connecting component 50, the melting point of the solder material in connection portion 2 may be 210°C to 240°C, or 220°C to 230°C. When the melting point of the solder material is within the above range, the heat resistance and the connectivity of the insulated electrical wire in heat shrinkable connecting component 50 can be made good by combining heat shrinkable tube 1 and the solder material.

[0037] [Sealing Portion]

Sealing portion 3 is made of a sealing material. As the sealing material, for example, polyolefin resin, fluororesin, or fluororubber can be used. More specifically, as the sealing material mentioned above, one or more of the following can be used by mixing: high-density polyethylene (HDPE), low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), ethylene-vinyl acetate copolymers (EVA), ethylene-ethyl acrylate copolymers (EEA), ethylene-methyl methacrylate copolymer (EMMA), polyvinylidene

Test No.		1	2	3	4	5	6	7	8	9	10	11	12
Main Component Resin of Heat Shrinkable Tube	Composition	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE
Properties of Heat Shrinkable Tube	Melting Point of Tube [°C]	225	225	225	225	225	225	225	225	225	225	225	225
	Storage Modulus at 250°C to 280°C [MPa]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Properties of Sealing Material	Composition of Sealing Material	THV + EVA	THV + EVA	THV + PVDF	THV	THV	THV	THV	THV	THV	THV + EVA	THV + PVDF	THV + PVDF
	Amount of Silica Added [parts by mass]	0.2	0.8	0.8	1.0	1.5	2.5	3.0	3.5	4.0	4.5	4.5	5.0
	Shear Viscosity of Sealing Material [Pa·s] Temperature 250°C, Shear Rate 100/s	800	1000	900	1000	1100	1300	1800	1900	2000	2000	2500	3000
	Shear Viscosity of Sealing Material [Pa·s] Temperature 215℃, Shear Rate 0.01/s	5000	6000	7000	7000	10000	15000	50000	60000	70000	85000	70000	100000
Properties of Solder Material	Composition of Solder Material	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu	Sn Ag Cu
	Melting point of Solder Material [°C]	223	223	223	223	223	223	223	223	223	223	223	223
Evaluation of Heat Shrinkable Connecting Component	Sealing Ability of Heat Shrinkable Connecting Component	D	D	D	C	B	A	A	B	C	D	D	D

Test No.		51	52	53	54	55	56	57	58
Main Component Resin of Heat Shrinkable Tube	Composition	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE	ETFE
Properties of Heat Shrinkable Tube	Melting Point of Tube [°C]	225	225	225	225	225	225	225	225
	Storage Modulus at 250°C to 280°C [MPa]	0.8	1.0	1.2	1.6	2.0	2.8	1.0	1.0
Properties of Sealing Material	Composition of Sealing Material	THV FKM	THV FKM	THV FKM	THV FKM	THV FKM	THV FKM	THV FKM	THV FKM
	Amount of Hydrotalcite Added	1.5	1.5	1.5	1.5	1.5	1.5	0.8	3.5
	Shear Viscosity of Sealing Material [Pa·s] Temperature 250°C, Shear Rate 100/s	1200	1200	1200	1200	1200	1200	1000	2000
	Shear Viscosity of Sealing Material [Pa·s] Temperature 215°C, Shear Rate 0.01/s	13000	13000	13000	13000	13000	13000	7000	70000
Properties of Crimp Sleeve	Material of Crimp Sleeve	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
	Surface Treatment of Crimp Sleeve	Ni plating	Ni plating	Ni plating	Ni plating	Ni plating	Ni plating	Ni plating	Ni plating
Evaluation of Heat Shrinkable Connecting Component	Sealing Ability of Heat Shrinkable Connecting Component	B	B	A	A	B	B	C	C

[0097] As shown in Table 7, even when the crimp sleeves were used as the connection portions, the heat shrinkable connecting components No. 51 to No. 58, each in which the storage modulus of the heat shrinkable tube at 250°C to 280°C was 0.8 MPa to 2.8 MPa, the shear viscosity of the sealing material at 250°C with a shear rate of 100/s was 1000 Pa·s to 2000 Pa·s, and the shear viscosity of the sealing material at 215°C with a shear rate of 0.01/s was 7000 Pa·s to 70000 Pa·s, had sufficient sealing ability.

[0098] The above results show that the heat shrinkable connecting components are excellent in sealing ability and durability under a high temperature environment.

REFERENCE SIGNS LIST

[0099]

1 heat shrinkable tube

2 connection portion

3 sealing portion

5 conductor connecting portion

6, 16 conductor

7, 17, 24 insulating layer

8, 18 insulated electrical wire

11 heat shrinkable tube after shrinkage