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Fundamental of Heating

(1)Understanding of Heating Element

Heating element is the key role of electrical heating products. According to applied voltage, the electrical heating product is divided into two categories, AC power heating (110~240 voltage) and DC power heating (7.5~12 voltage). At present, the heating product we mostly find in market is AC power heating because of cheap price. However, insecure feeling caused by using AC power, such as electric shock, electromagnetic radiation, and overheating, etc, is always an issue. The DC power heating product (7.5~12 voltage) starts introducing to consumers. Table 1 analyses the differences between the AC power heating and DC power heating.

Table 1 Comparison between DC power heating and AC power heating

Heating Type	DC Power Heating	AC Power Heating
Heating Element	1. Carbon Fiber/Carbon Fabric 2. Flexible Printed Circuit Board(Film Heater) 3. Stainless Steel Fiber	1. Heating Wire 2. Carbon Fiber/Carbon Fabric
Merchandise	1. Small and Medium Size Blanket 2. Heating Pad 3. Heating Jacket	Large and Medium Size Blanket
Applied Voltage	7.5~12 Volt	110~240 Volt
Electromagnetic Radiation	Low Risk	In Doubt
Safety Design	No strict regulation needed	Need to meet strict regulation
Engery Consuming	Low	High
Weight	Light	Heavy
Retailer Price	About 80~150 USD in Taiwan	About 30~90 USD in Taiwan

We can understand that DC power heating product is a better system than AC power heating product, but more expensive. What caused DC power heating product the higher cost? Table 2 is the analysis.

Table 2 Cost Analysis for DC power heating product

Heating Element	Material behaviour	Welding	Material Cost	Production
Carbon Fiber/Carbon Fabric	Brittle, it could be partially broke in layout process or in using. The broken could cause variation of conductivity and seriously effect heating performance. Hence, It needs extra protection.	It cannot be welded with cable or PCB directly. Hence, an extra terminal is required. However, manufacturer must pay more attention on the terminal mounting quality. Bad quality could cause safety issue.	Raw material source is limited. Price depends on quality.	Most of manufacturers adopt manual layout. Hence, most of manufacturers are in emerging countries, especially in China.
Flexible Printed Circuit Board (Heating Film)	The circuit printing thickness is very thin. Hence, bending angle of the flexible board is limited.	It can be welded with cable and PCB.	Raw material is expensive.	Special equipments is required. The operation cost is very expensive.
Stainless Steel Fiber	Brittle, it could be partially broke in layout process or in using. The broken could cause variation of conductivity and seriously effect heating performance. Hence, It needs extra protection.	It cannot be welded with cable or PCB directly. Hence, an extra terminal is required. However, manufacturer must pay more attention on the terminal mounting quality. Bad quality could cause safety issue.	It is very special raw material and expensive. The source is very limited.	Most of manufacturers adopt manual layout. Hence, most of manufacturers are in emerging countries, especially in China.

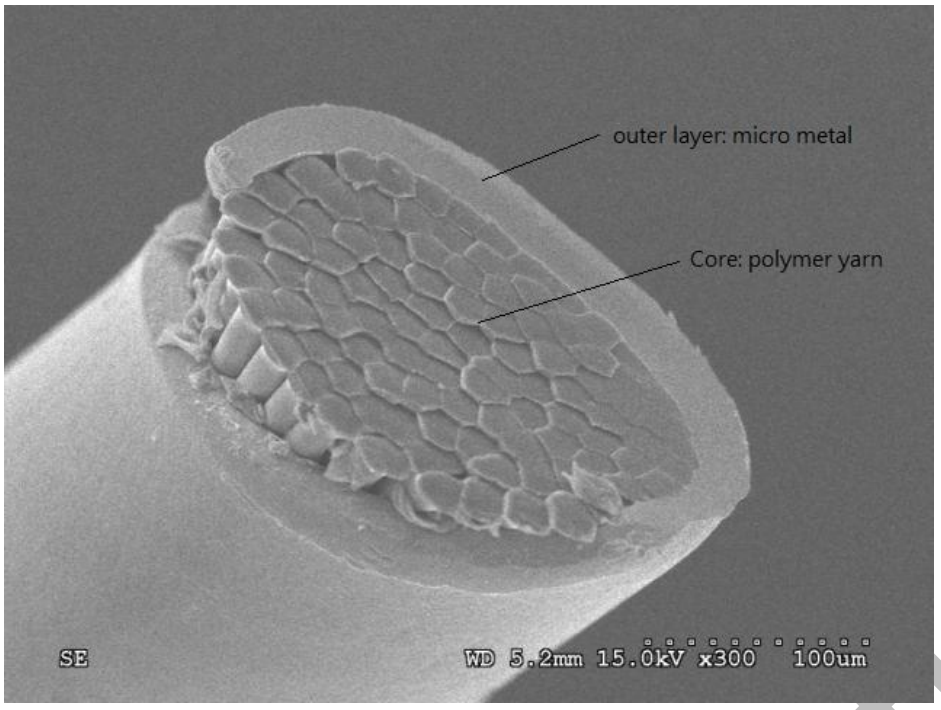
The layout of the carbon fiber

The Heating Film

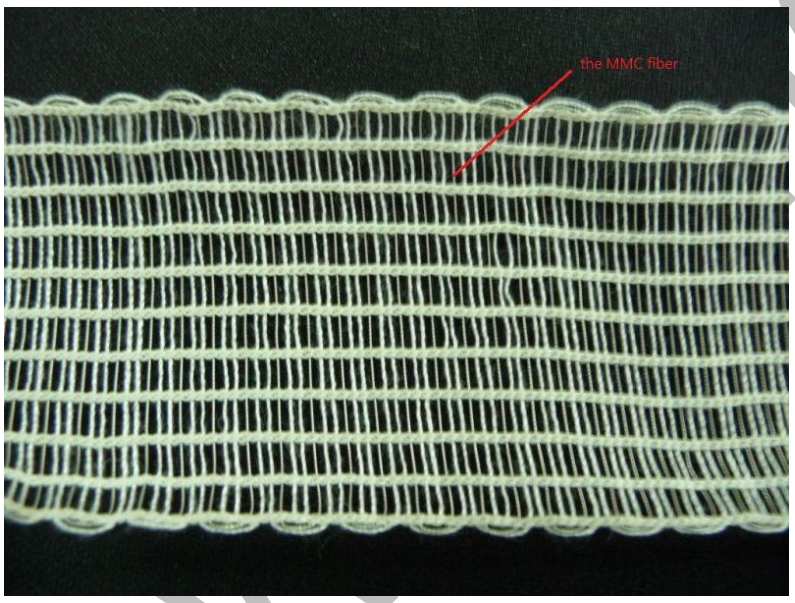
In conclusion, the DC power heating product has higher cost because

1. the heating element cannot be welded directly to cable or PCB, and an extra welding solution such as terminal mounting are needed.
2. the material property of the heating element is fragile, hence an extra safety solution is required.
3. most of manufacturers proceed the layout of the heating element by handwork or by expensive equipment.
4. the cost of raw material is higher than the traditional heating wire.

(2) Wirekinetics Innovative Solution-the Micro Metal Conductive Fiber



The Micro Metal Conductive Fiber



The Heating Fabric

Wirekinetic develops a total solution, **the Micro Metal Conductive (MMC)Fiber**, to solve the above problems.

The MMC fiber has a metal-polymer composite structure. The composite structure provides excellent toughness and compatibility with electrical processes. Hence,

1. **the MMC fiber can be welded directly with cable or PCB, and don't need any extra welding and safety solution.**
2. **the composite structure design of the MMC fiber can provide DC and AC power heating applications through different combinations of metal and polymer. For example, the MMC fiber**

uses high performance polymer such as PBO as the core, then the MMC fiber can be heated to 500℃. That is, the MMC fiber can be used in industrial heating.

3. **the layout can be proceeded by automatic textile machines such as weaving, knitting etc. because of the excellent toughness of the MMC fiber. Our capacity of the heating fabric woven by the MMC fiber is huge, approximately 350,000 meters per month. In addition, the pitch of the layout can be very tight. The minimum of the pitch can go to 2 mm. The heating density will be very high. That is, the heating rate will be very fast, and the energy consuming will be very low.**
4. **the layout of the MMC fiber is a heating fabric. Thus, the layout is very light and flexible, but tough. It can resist complicated stresses.**
5. **the MMC fiber and the heating fabric are invented and made in Taiwan. The quality is ensured.**