APPLICATION OF SELF-ADHESIVE CONDUCTIVE MATERIAL ON TEXTILES

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Abstract: *A basic overview of electronics on textiles is given with an emphasis on self-adhesive conductive materials and their characteristics. It is kept on materials, self-adhesive conductive textiles and metal tapes and foils, which can be easily obtained. Their advantages compared to other techniques for electronics on textiles are described. The proposed structure is for the microwave area, which is a demanding area with regard to high frequencies.*

Keywords: Electronic textile, Conductive textile, Copper tape, Filters, Microwaves.

PRIMENA SAMOLEPLJIVOG PROVODNOG MATERIJALA NA TEKSTILU

Apstrakt: *Dat je osnovni pregled elektronike na tekstilu sa akcentom na samolepljivim provodnim materijalim i njihovim karakteristikama. Zadržano je na materijalima, samolepljivom provodnom tekstilu i metalnim trakama i folijama, koji se mogu lako nabaviti. Opisane su njihove prednosti u poređenju sa ostalim tehnikama kod elektronike na tekstilu. Predstavljena je struktura za oblast mikrotalasa što je zahtevna oblast s obzirom na visoke frekvencije.*

Ključne reči: Elektronika na tekstilu, provodni tekstil, bakarna traka, filtri, mikrotalasi.

1. INTRODUCTION

Electronic textile is increasingly used in modern electronics [1-17]. The field developed very quickly and acquired a large number of applications from ordinary life to special medical controls. This substrate also has its limitations, which are reflected in the variation of up to 10% of the values of parameters such as dielectric constant and thickness [6]. It can make problems in simulation. Problem can also be with washing and friction.

Primarily, it was for EM shielding. The electronic textiles (*E-textiles*, *Textronix*) strict definition is where electronically conductive fibers or components are incorporated into a textile. *Smart textile* has some kind of intelligence, *functional yarns*. A historical development of electronic textiles is presented in Fig. 1 [11].

Conductive structures techniques on textiles can be generally divided into:

- Conductive layers, tapes and foils, which are glued (often self-adhesive) to the textile substrate.
- Conductive inks and pastes that are applied as surface colors to the basic textile substrate. (A textile that has been treated to be conductive can also itself be used for bonding to a basic textile substrate as an adhesive conductive layer).
- Conductive thread that is embroidered into the textiles (for example [17]).

The advantages of self-adhesive conductive tapes and foils compared to the other two mentioned techniques are:

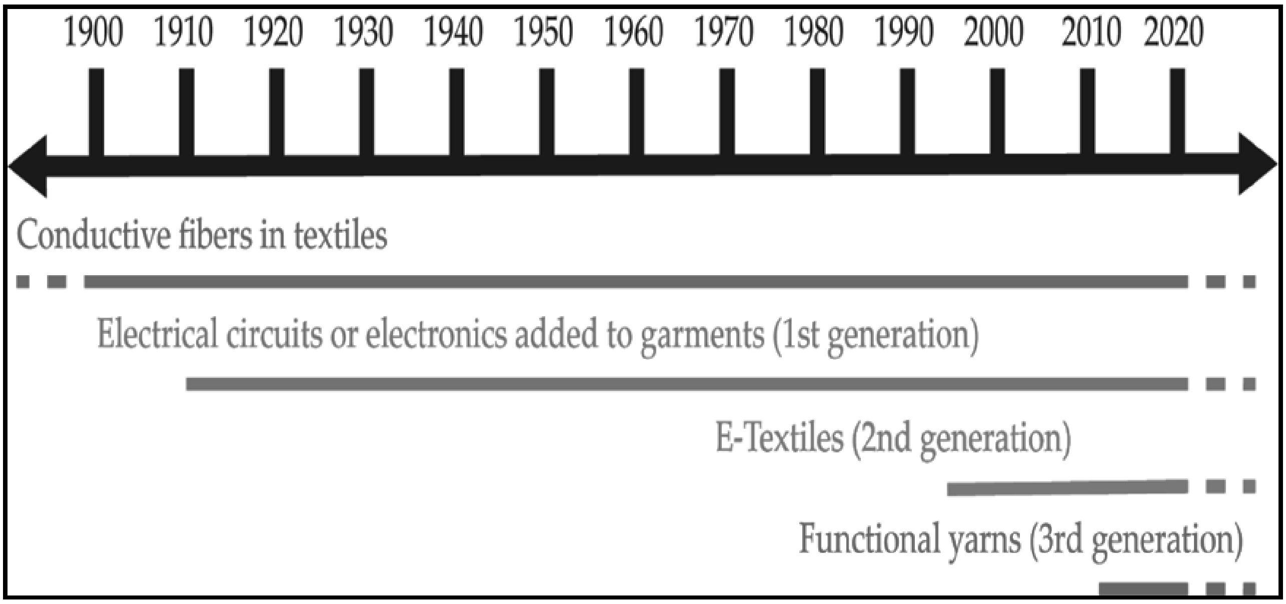

Figure 1: A historical development of electronic textiles [11]

- The special self-adhesive tape as a sacrificial layer enables the transfer of the formed conductive structure to textile surfaces. It also solves the problem of large areas, such as clothes, as well as curved surfaces where it is impossible to easily cut.
- The definition of thickness of the conductive layer is like in common electronic structures such as PCB (printed circuit board). It obtains better definition of the layer and better simulation.
- Easy for conductive connections in case of conductive glue. Creation of a multilayer structure of the conductive layer that increases the conductivity [13] or electrically connects parts of the structure [14-16].
- Good for general multilayer, conductive and dielectric layers in levels.
- The self-adhesive conductive layer enables the detachment of the conductive layer and the re-formation of a new one without damaging the basic substrate. It is possible to peel off the conductive layer together with the bond without damaging the basic substrate.

The use of conductive textiles as metallization is very actual [8-10,13-16]. It lags behind pure metal in conductivity but also has advantages. The advantage over the pure metal layer is primarily in the flexibility and mechanical resistance coupled with the use of textiles [9,10,13].

Despite this, the use of self-adhesive metal tapes, especially copper but also aluminum, are very current. The biggest advantage over conductive textiles is higher conductivity, but also easier bonding, especially copper with common soldering. The disadvantage is a tendency to wrinkles the copper while the conductive textile remains flat.

Both self-adhesive conductive textile and self-adhesive copper tape give the possibility of easy removal of the conductive structure and installation of a new one without damaging the substrate.

The example application is on microwave structures like in [14], but can be also on lower frequencies. The microwave structure is taken as an example as the most demanding due to the high frequencies.

2. MATERIALS

Self-adhesive conductive tapes and foils are selected for application. The grid conductive cloth tape (*Xinst0402/12*, *Shenzhen Xinst Technology Co., Ltd*) total thickness (textile + conductive glue) 120 µm was used for conductive textiles with conductive adhesive. The conductivity of a given textile with a copper-nickel structure and polyester is about 10^5 S/m. A photograph of the surface and its photomicrograph is shown in Fig. 2. The disadvantage is the presence of plastic that makes it difficult to common soldering or bonding with silver epoxy paste.

The copper tape (copper 30 µm + non-conductive glue 30 µm). Now, the copper tape with conductive glue is available. The copper bulk conductivity is $58 \cdot 10^6$ S/m but usually chosen $18 \cdot 10^6$ S/m.

The patterns were done in handmade cutting using precision scalpel and a drawing table Fig. 3. The

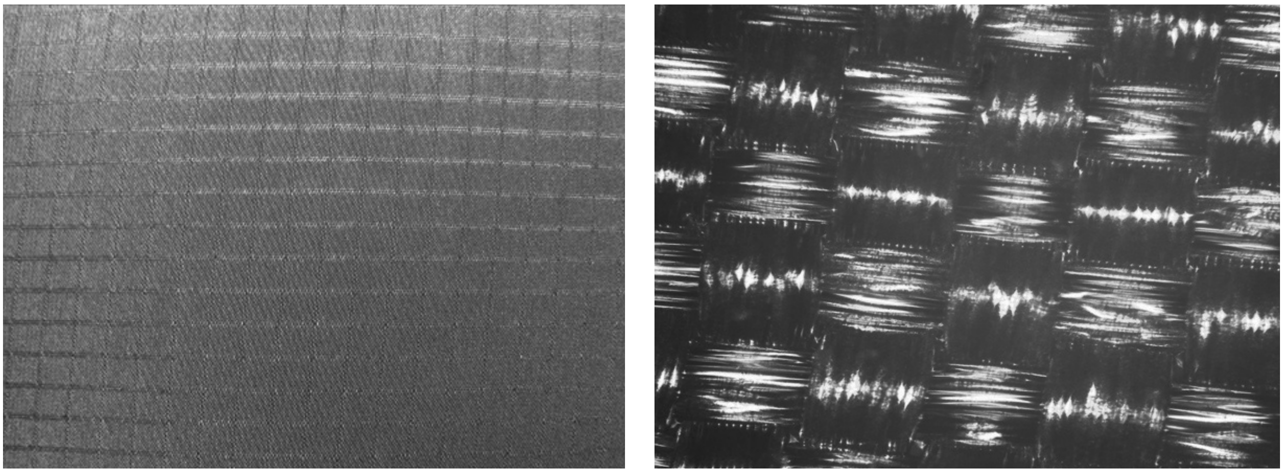

Figure 2: Photography and microscopic photography of conductive textiles (Motic 100x) [14]

dielectric constant of the used felt substrate is below 1.5, in our case between 1.2 and 1.3. Since the thickness is not small (actually about 0.85 mm) the 50 Ω line is about 3.5 mm. The step in manual cutting is 0.5 mm, so the maximum error is 0.250 mm.

There is a tendency to wrinkles the copper while the conductive textile remains flat after cutting, as can be seen in Fig. 4. It is one advantage over the pure metal layer.

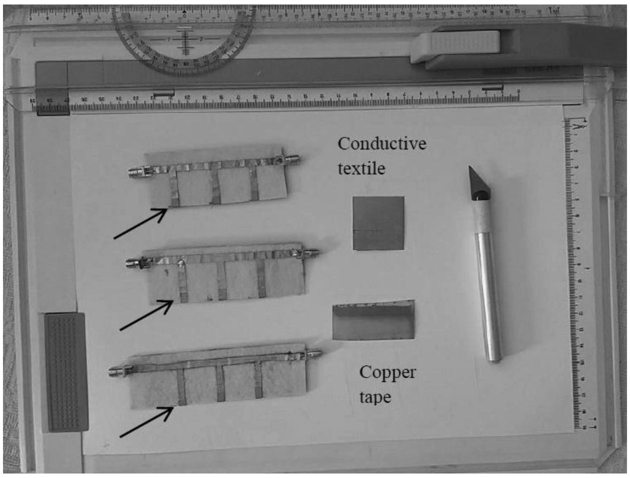

Figure 3: One precision scalpel and a drawing table for handmade cutting [14]
Arrows are position of the short-circuited edge conductive textile.

The special self-adhesive tape (*Scotch Removable*) as a sacrificial layer enables the transfer of the formed conductive structure to textile surfaces, Fig. 5. It also solve the problem of large areas, such as clothes, as well as curved surfaces where it is impossible to easily cut.

Figure 4: Copper and conductive textiles cut with a precision scalper

There is a tendency to wrinkles the copper while the conductive textile has remained flat [14].

3. APPLICATION ON MICROWAVE FILTERS

In Fig. 6 photos from above and below of the filter with copper strip are given. Wrinkled copper surface can be seen. In Fig. 7 is a photograph of the structures with conductive textiles. You can see the use of short-circuited edges using conductive textiles (gray) with conductive glue in both cases, similar to that in [13-16]. Even the author's work [14] was published before [16].

For better soldering, Fig.8, next to the connector is copper, which is partly covered with the conductive textiles. SMA connectors above and below are presented in details. Soldering on conductive textiles is more difficult, so copper is placed in the first part.

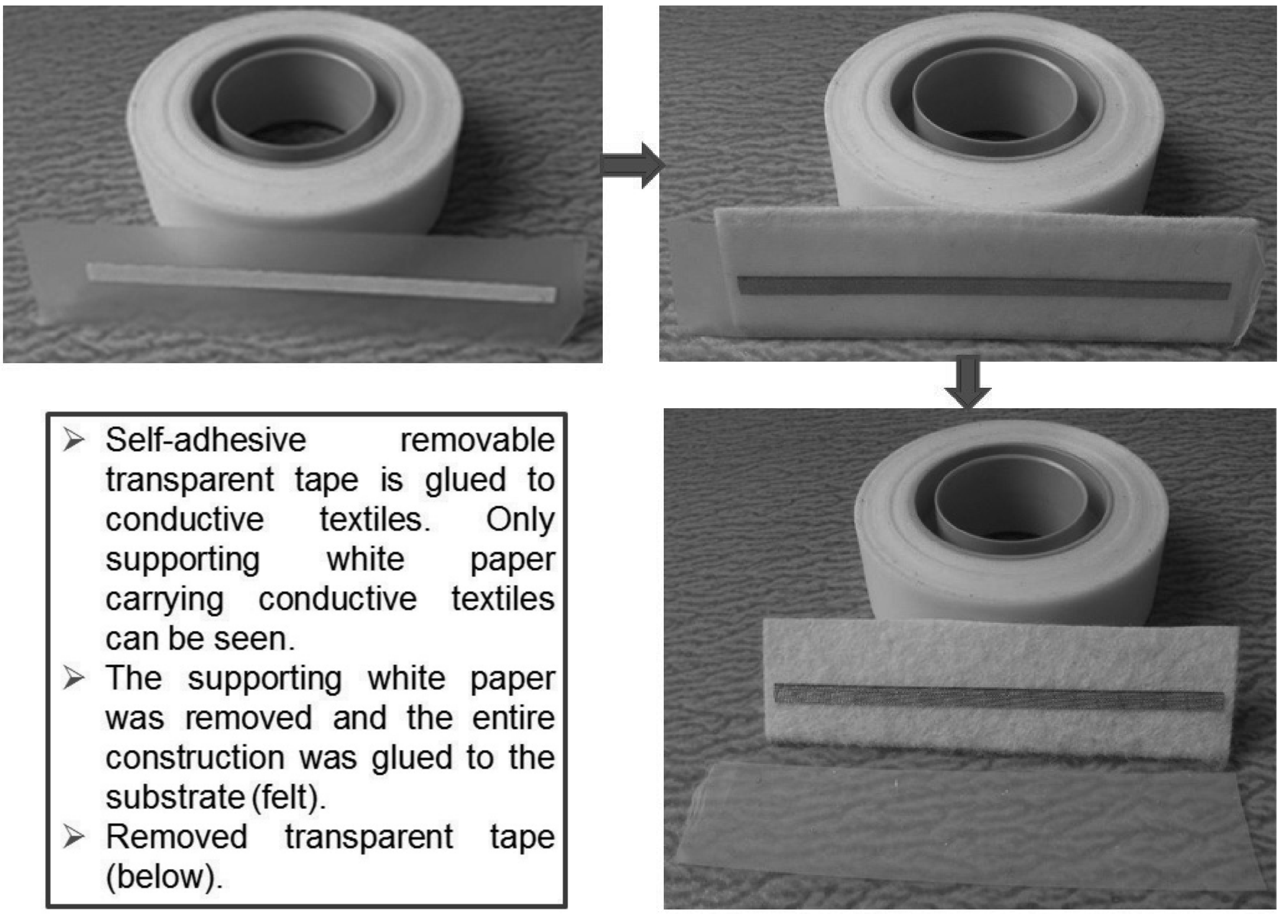

Figure 5: Using a special self-adhesive tape as a sacrificial layer

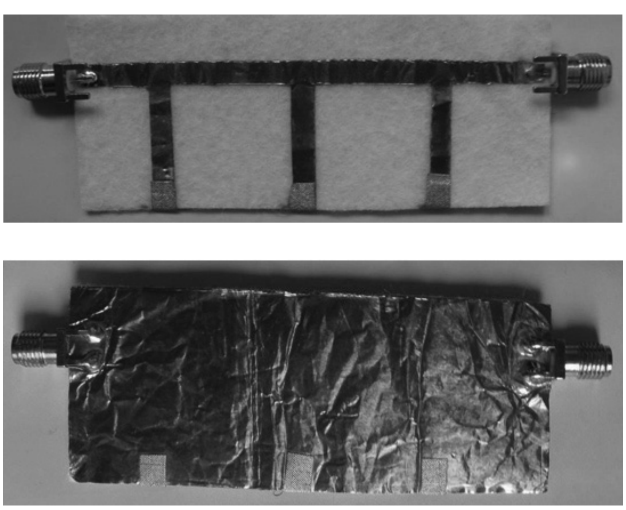

Figure 6: Structure with copper strip from above and below [14]

Short-circuited edges conductive textiles, gray, with conductive glue can be seen in lower part of figures.

Wrinkled copper surface can also be seen.

There is a general problem with joining SMA connectors due to the nature of the material. The textile conductor is difficult to solder, and the problem is the low resistance to high temperatures of the basic textile and the glue. Sometimes silver-epoxy can be a better choice, but only for copper, not our conductive textiles. The problem can also be the stiffness and dimensions of the SMA connector, so the solution can be miniature SMA connectors as in [17] or try without the connector using strips with conductive glue.

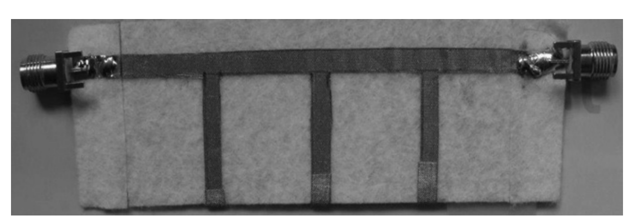

Figure 7: Structure with conductive textiles from above. One can see the use of shorting on the edge [14]

CONCLUSION

The advantage of conductive textiles is the applicability of electronics to clothes and other textile materials, while making them functional for use. The lack is a textile material as a substrate that does not have

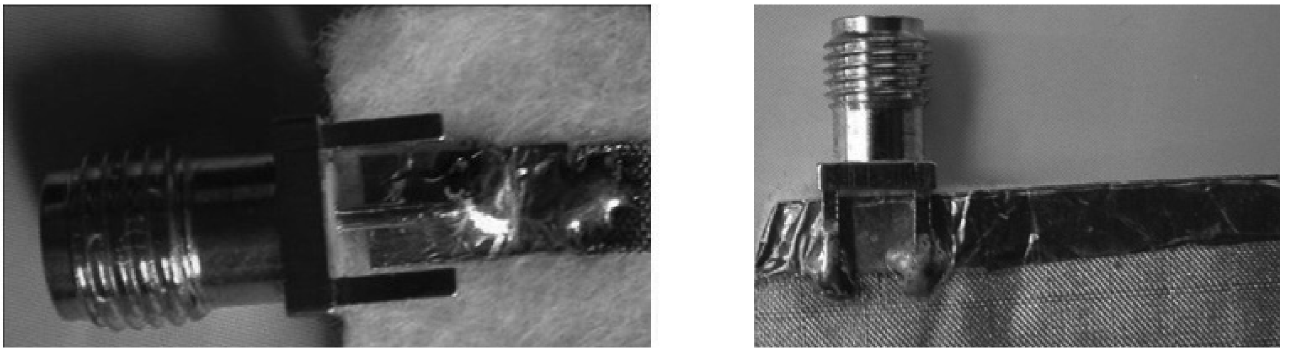

Figure 8: SMA connector details above and below the conductive textile filter [14]
The copper is placed in the first part.

a precisely defined thickness and dielectric constant. Some problems can be with washing and friction.

The biggest advantage of copper tape over conductive textiles is higher conductivity, but also easier bonding of copper with common soldering. It is problem with connector bonding due to the nature of the material (difficult bonding of textile conductor and also low resistance to high temperatures of textiles and glue).

The problem can also be the stiffness and dimensions of the SMA connector, so the solution can be miniature SMA connectors or try without the connector using strips with conductive glue.

The advantages over other techniques such as applying conductive ink or paste and embroidery with conductive thread are:

- By applying a special self-adhesive tape as a sacrificial layer, it is possible to transfer the formed conductive structure in the form of a self-adhesive conductive layer to surfaces where etching or other invasive shaping methods are difficult to perform.
- The definition of thickness of the conductive layer is like in common electronic structures (better simulations).
- Easy for conductive connections in case of conductive glue. Creating a multilayer structure with a conductive layer that increases conductivity or electrically connects parts of the structure.
- Good for general multilayer, conductive and dielectric layers in levels.
- The self-adhesive conductive structure allows removing or even repairing the conductive layer and forming a new one without damaging the substrate.

The microwave structure is taken as an example as the most demanding due to the high frequencies. The branches are short-circuited with a conductive strip on the edge (short-circuited edge).

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