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PADDING ANTENNA WITH METALLIC FABRIC TO IMPROVE ITS EFFICIENCY TO REFLECT RF RADIATION AND RESIST CLIMATIC CONDITIONS

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ABSTRACT

Metallic fibers are manufactured fibers composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal.[1] Gold and silver have been used since ancient times as yarns for fabric decoration. More recently, aluminum yarns, aluminized plastic yarns, and aluminized nylon yarns have replaced gold and silver. Metallic filaments can be coated with transparent films to minimize tarnishing.The most common uses for metallic fibers are upholstery fabric and textiles such as lamé and brocade. Many people also use metallic fibers in weaving and needlepoint. Increasingly common today are metallic fibers in clothing.

The aim of the research is to use metallic fabric in padding Antenna to increase RF wave's absorbance and reflection. Metallic Fiber of (120 denier) is used as a weft to produce fabric with satin weave structure.

When metallic fabric put on THz-TDS apparatus for measuring transmittance, the readings of the apparatus were high absorbance factor.

I. INTRODUCTION

For many years the textile world was very simple when it came to the function of textile. With increasing use of the term "functional textile", the situation has become more complex.Metallic fibers have been used since ancient times as decoration in the clothing and textiles of kings, leaders, nobility and people of status. Many of these elegant textiles can be found in museums around the world.[2] Historically, the metallic thread was constructed by wrapping a metal strip around a fiber core (cotton or silk), often in such a way as to reveal the color of the fiber core to enhance visual quality of the decoration.[3] Ancient textiles and clothing woven from wholly or partly gold threads is sometimes referred to as *Cloth of Gold*. They have been woven on Byzantine looms from the 7th to 9th Centuries, and after that in Sicily, Cyprus, Lucca, and Venice.[4] Weaving also flourished in the 12th Century during the legacy of Genghis Khan when art and trade flourished under Mongol rule in China and some Middle Eastern areas.[5] The Dobeckmum Company produced the first modern metallic fiber in 1946.[2] In the past, aluminum was usually the base in a metallic fiber. More recently stainless steel has become a base as well. It is more difficult to work with but provides properties to the yarn that allows it to be used in more high tech applications.[2]

Many researches have studied the reflection property of textile. This property is related to the textile material properties and fabrication conditions, reflection measurement could reveal the underlying relationships and thus help understand the impacts of the weaving patterns and physical parameters on the textile colors and appearances.(6)

II. METHODOLOGY

2.1 Spinning of Metal Fiber

There are two basic processes that are used in manufacturing metallic fibers. The most common is the laminating process, which seals a layer of aluminum between two layers of acetate or polyester film. These fibers are then cut into lengthwise strips for yarns and wound onto bobbins.These fibers can count according to its filament width with inch like 1/100, 1/80

Metallic fibers can also be made by using the metalizing process. This process involves heating the metal until it vaporizesthen depositing it at a high pressure onto the polyester film. This process produces thinner, more flexible, more durable, and more comfortable fibers. (7)

Metallic fibers are flat, ribbon-like filaments, commonly 3.2-0.2 mm (1/8-1/128 in) width. They are smooth-surfaced, and may be colored or uncolored. Tenacity is ranging from (0.3 to 1.25 gm. / din.) this is depending on the kind of material. Elongation is raging between (30% to 140%) . they are resistant to fraction , acids, weak alkalis, and sun light but Some loss of strength on prolonged exposure.(8)

2.2 The Reflection Theory Of Textile

The simple definition of luster is the way light is reflected from surface. This is a subjective measure of the reflection of incident light from a fiber, filament or textile material. The more lustrous a fiber, the more evenly does it reflect the incident light. The less lustrous or dull fiber or filament, the less evenly does it reflect or the more does it scatter the incident light. Cotton has a convoluted fiber structure and wool a serrated surface structure, the result is that these fibers scatter the incident light, and are thus dull fibers. The more regular and even surface structure of flax, mercerized cotton and silk gives these fibers a distinct luster, due to the even reflection of incident light. The irregular specks of dull agent contained within not shiny man-made fibers scatter sufficient of the incident light to make these fibers or filaments duller than their bright luster equivalents. A preference for non-lustrous or dull textile fibers and filaments exists. This is evident in the predominance of dull-lustrous or non-lustrous apparel and household textiles normally purchased and used by consumers. Cross-section of fiber effects upon luster and other physical fiber properties.

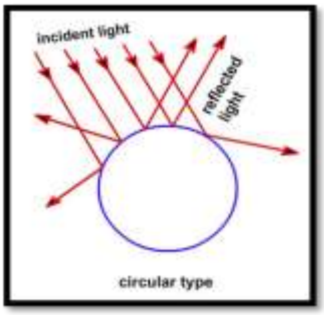

Fig. (1) the behavior of cross section of fiber when light incidents.

Circular cross-sectional shape imparts strong luster to the fiber or filament because the incident light is reflected so unevenly, this tends to result in a rather harsh, strong luster.(9)

2.3 Definition Of RF Radiation And Its Use

Electromagnetic radiation consists of waves of electric and magnetic energy moving together (that is, radiating) through space at the speed of light. Taken together, all forms of electromagnetic energy are referred to as the electromagnetic spectrum. Radio waves and microwaves emitted by transmitting antennas are one form of electromagnetic energy. Often the term electromagnetic field or radiofrequency (RF) field may be used to indicate the presence of electromagnetic or RF energy.The RF part of the electromagnetic spectrum is generally defined as that part ofthe spectrum where electromagnetic waves have frequencies in the range of about 3 kilohertz (3 kHz) to 300 gigahertz (300 GHz). Probably the most important use for RF energy is inproviding telecommunications services. Radio and television broadcasting, cellular telephones, radiocommunications for police and fire departments, amateur radio, microwave point-to-point links, and satellite communications are just a few of the many telecommunications applications. Microwave ovens are a good example of a non-communication use of RF energy. Other important non-communication uses of RF energy are radar and for industrial heating and sealing. Radar is a valuable tool used in many applications from traffic enforcement to air traffic control and military applications. Industrial heaters and sealers generate RF radiation that rapidly heats the material being processed in the same way that a microwave oven cooks food.

Radio and television broadcast stations transmit their signals via RF electromagnetic waves. Broadcast stations transmit at various RF frequencies, depending on the channel, ranging from about 550 kHz for AM radio up to about 800 MHz for some UHF television stations. Frequencies for FM radio andVHF television lie in between these two extremes. Operating powers can be as little as a few hundred watts for some radio stations or up to millions of watts for certain television stations. Some of these signals can be a significant source of RF energy in the local environment, and the FCC requires that broadcast stations submit evidence of compliance with FCC RF guidelines.

Fig (2) 50 Feet dish Antenna of an 3 kW C-band Radar

The amount of RF energy to which the public or workers might be exposed as a result of broadcast antennas depends on several factors, including the type of station, design characteristics of the antenna being used, power transmitted to the antenna, height of the antenna and distance from the antenna. Since energy at some frequencies is absorbed by the human body more readily than energy at other frequencies, the frequency of the transmitted signal as well as its intensity is important.[10]

III. EXPERIMENTAL WORK

This study aimed to produce fabrics used for padding antenna using poly-ester warp count 150 denier and poly-ester and metal yarnsof 120 denier.

Three different woven structures were also used for producing samples under study, twill 1/3 , weft backed weave and double layer

3.1 The Specifications Of Machine

Satin-10 woven structures is used for producing samples under study with three different ratio of metallic fiber

table(1)specifications of the machine used for producing samples under study

No.	Property	Specification
1	**Machine type**	**Somit**
2	**The manufacturer country**	**France**
3	**Shedding system**	**Jackerd**
4	**Jackerd type**	**Staubli**
5	**Machine wideh**	**150 cm**
6	**Number of healds**	**2688**
7	**Machine speed**	**280 – 320 picks/ min**
8	**Reed used(dents / cm)**	**11 dents /cm**
9	**Denting**	**6 ends per dent**

3.2 The Specifications of Samples

Table (2) specifications of samples

no	Number of warp/ cm	Number of weft/ cm	Weaving structure	Ratio of wefts	
				metal	Poly-ester
1	66	20	Satin-10	25%	75%
2	66	20	Satin-10	50%	50%
3	66	20	Satin-10	75%	25%

3.3 Measuring The Absorbance Factor

Terahertz time-domain spectroscopic system (THz-TDS) of the type TPS Spectra 3000 (TeraView, U.K) was used in this study. It has a frequency range from 6 GHz to 4 THz and a maximum 300 ps delay time. Both the generation and detection of THz radiation originate from an ultrafast, femtosecond laser pulse at a near-infrared (NIR) wavelength.

The system is composed of TDS pulse system and frequency-domain continuous wave (CW) system. For spectroscopic applications, a broad band of THz frequencies is needed, particularly for the analysis of solid samples where the absorption bandwidth can be broad [1]. Frequency range of CW System is 50 GHz-1.5 THz and maximum definition can be obtained at 100 MHz.

The setup for THz time domain spectroscopy (TDS) in the transmission configuration is shown in figure (2.5). It is realized by placing the sample between the THz emitter and receiver, and the THz radiation passes through the sample[1]. The THz time domain spectrum is established by recording the magnitude of the electric field vector of the broadband THz pulse as a function of time. The time delay of the measured signal corresponds to the rate at which the THz radiation travels through the sample cell and reaches the detector. Fourier transformation can then be applied to convert this TDS to a frequency domain spectrum.

Absorbance (A) can be calculated from the intensity of sample single-beam spectrum ($\mathbf{I_{sample}}$) and the intensity of reference single-beam spectrum ($\mathbf{I_{reference}}$) from the following equation:

$$\mathbf{A} = -\log \frac{\mathbf{I_{sample}}}{\mathbf{I_{reference}}}$$

Transmittance (T) is defined as[2]: $\mathbf{T} = \left|\frac{\mathbf{E_{sample}}}{\mathbf{E_{reference}}}\right|^2$ where $\mathbf{E_{sample}}$ and $\mathbf{E_{reference}}$ are the complex electric field intensities passing out of the sample and the reference electric field incident on the sample respectively.

Total shielding effectiveness ($\mathbf{SE_{total}}$) of the sample is calculated from transmittance (T) using the following relation [2]:

$$\mathbf{SE_{total}} = -10 \log \mathbf{T}$$

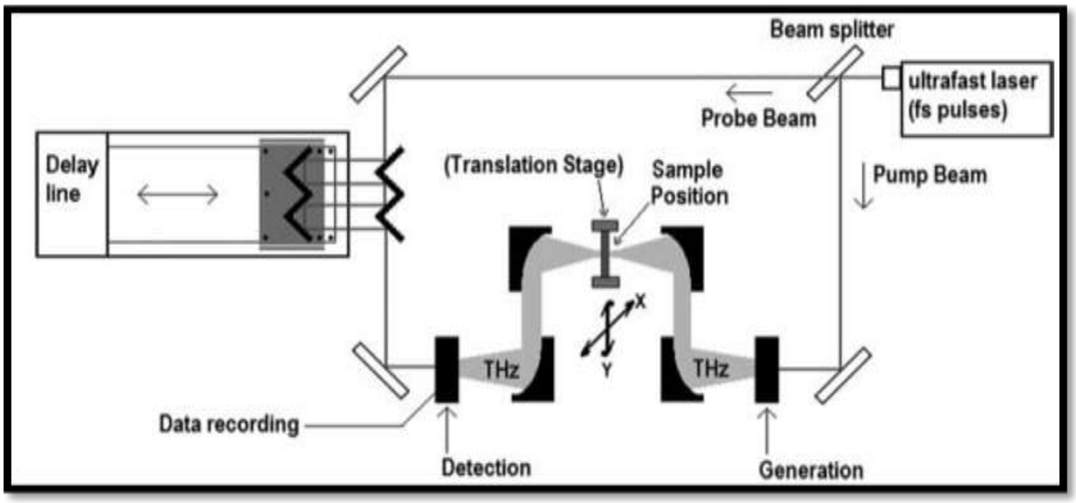

Figure (3): Configuration of a THz-TDS apparatus for measuring transmittance [1].

THz-TDS has also the capability of measuring refractive index and absorption coefficient as a function of frequency. This gives a possibility to calculate the dielectric permittivity based on refractive index and phase angle data.

IV. RESULTS AND DISCUSSIONS

4.1 The Results Of Measuring Samples On Apparatus

In this work, a relatively recent technique has been utilized to calculate the effectiveness of the fabric to reflect electromagnetic waves. By using THz-TDS technique, one can accurately measure the transmittance of samples over a wide frequency band ranging from 10-1000 GHz. Total electromagnetic shielding effectiveness can thus be computed using the following relation(11).

In addition to the broad spectrum and the giant capabilities of the instrument, another advantage of the use of THz-TDS is that sample thickness is taken into account during transmittance calculation. Thus transmittance is already normalized for sample thickness. This eliminates the need for preparing various samples with different thicknesses or to construct a relation between sample thickness and shielding effectiveness. Based on the knowledge of skin depth, one can calculate the suitable thickness, when needed, to design a practical shielding structure.

metal fibers doped fabrics are usually fabricated in order to improve the electromagnetic wave absorbing properties. The structure is composed of a matching layer and an absorption layer. The matching layer is the surface layer through which most of the incident waves can enter suffering little or no reflection, while the absorption layer beneath enhances attenuation of transmission of electromagnetic waves (12).

The absorbance of the copper doped fabric increases nearly proportionally with increasing frequency. This means that the ability of the fabric to absorb electromagnetic waves in the range 6 GHz up to 2000 GHz is favorable. Moreover, the ability of the material to act as either shield of the underneath material or the reflecting property of such fabric is also expected.

Recommendations

1- Using metallic fabric in padding Antenna in wide range to increase the absorption waves especially with advancement of waves with frequency 2 G.hz.
2- Workout with different kinds of weaving structure and different count of metal fiber to produce sample could deal with high frequency.

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