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Research paper

Image Processing Algorithm for Calculating Uniformity of Carbon Surface Image Heating Element

[1]Hyung-Soo Hwang, *[2]Joon-Ho Cho

[1]Department of Electronics Convergence Engineering, 460 Iksaniksandae 460, Iksan city, Jeonbuk, 54538, Republic ofkorea
[*]Corresponding author E-mail: cho1024@wku.ac.kr

Abstract

Background/Objectives: In this paper, numerical calculation method using image processing technology for percentage and uniformity of carbon fibers of planar heating element was proposed.
Methods/Statistical analysis: The manufacturing method of the planar heating element is made by chopping the carbon fiber in small size and bonding it again via the dispersing agent. Filter the carbon fiber solution bound using a dispersant on the next nonwoven fabric. The last step is to obtain planar carbon fibers in the form of nonwoven fabrics for drying the filtered carbon fibers.
Findings: n the planar heating element, electricity may be applied to the carbon fiber on the surface produced in this manner. Calculation of the ratio and uniformity of the planar heating element in this paper addressed four sample images (0.2 wt.%, 0.4 wt.%, 0.8 wt.%, 2.4 wt.%). In this method, the image of the planar heating element was divided into 5 × 5, converted into a binary image, and then the ratio and uniformity were numerically calculated.
Improvements/Applications: The image analysis of the planar heating element proposed in this paper can be interpreted more accurately by combining it with the conventional method.

***Keywords:** Carbon fiber, Image processing, Uniformity, Ratio, Planar heating element*

1. Introduction

Carbon fiber is a non-graphitic carbon obtained by stabilizing and carbonizing a precursor fiber produced by spinning an organic material such as an organic fiber, resin, pitch or the like and stretching and graphitizing at 2500 ° C. or higher Of the filament. Carbon fiber has high elastic coefficient and strength, low thermal expansion coefficient and high electric conductivity. It also has vibration damping characteristics, biocompatibility and creep resistance, and is also excellent in fatigue characteristics, corrosion characteristics, friction and abrasion characteristics, chemical stability and the like. In particular, carbon fibers have lower density than metals and ceramic materials, superior mechanical properties such as nose (Specific Strength), etc. and are extremely useful as reinforcing materials for composite materials such as organic polymers, metals, ceramics and carbon It is appropriate [1-4]. Since the 1960's, carbon fibers that are much lighter than glass fiber, superior in strength and elasticity have been developed, carbon fiber composite materials (Carbon Fiber-reinforced Composite) are being intensively developed, and since the 1980's tennis It began to be widely used in sports equipment such as rackets, golf clubs and skis, competition boats, automobiles, airplanes, building materials, helmets, instruments etc. [5, 6] planar heating element is a product that can reduce power consumption by 20 to 40% compared with conventional electric heating element, it can utilize radiant heat by electric current supply, easy temperature adjustment, air Since there is no contamination, it is hygienic and there is no noise, so it is used for heating devices such as heater mats, beddings, home heating systems, etc. Recently, various industrial heating devices such as printing drying and painting drying etc. , Agricultural equipment such as vinyl house and livestock barns, leisure, household electrical appliances, and the like. The material technology of the planar heating element having excellent thermal characteristics at the time of manufacturing the planar heating element and the process technology and apparatus technology for uniformly applying the heating element material so as to have the required heat and electric conductivity characteristics are important Technology.
Resistance heat is generated by the thick film resistance of carbon which is a heating element when a current flows in a planar heating element of a carbon material. In general, a carbon composite heating material obtained by mixing a carbon powder and a binder is used, and a high conductivity , Thermal conductivity, heat resistance, etc., studies for improving reliability and stabilizing quality are actively conducted. Normally, the screen printing method is often used in the printing process used in manufacturing the heating element, but in the screen printing method, laminate printing is impossible and it is necessary to adjust the conductivity and calorie as well, so the product is uniform In addition to deteriorating the quality and reliability, there are disadvantages that various kinds of products can’t be manufactured. In order to compensate for the drawbacks of this screen printing method, recently, a gravure printing method using a mesh-processed printing roll has been developed so that a carbon composite material (ink state) can be relatively uniformly applied. However there are still insufficient points to realize uniform heating characteristics. It begins at the contact part between the carbon fibers of the heat generating part of the carbon fiber nonwoven fabric. However, contact points produced using a carbon fiber nonwoven fabric with a short fiber of about 6 to 9 mm and a diameter of 7 [mu] m smaller and 50 [mu] m in

thickness are thermally diffused a lot [7 - 10].
The thermal conductivity of the carbon fiber is as high as 180 w / m 揃 k, and the heat released from the contact spreads throughout the carbon fiber. By such a mechanism, the thermal image of the carbon fiber nonwoven fabric is the same as the planar heating element. Heat generated by metal wires and carbon fibers spreads to conduction, convection, and copying. Existing metal wires had to accompany the heat diffusion layer at all times to dissipate locally generated heat. During this process the heat escaped to undesirable places and a loss of 25% occurred. On the other hand, since the planar heating element is in direct contact with a desired heat transfer part, most of the heat is transferred by conduction. For these reasons, the use efficiency of generated heat will rise by 25%.
A planar heating element using a carbon fiber is a material which has improved defects of heat rays. The addition rate and uniformity of the carbon fibers of the planar heating element have a close relationship with the heat generation. Therefore, calculation of the proportion and uniformity of carbon fiber is very important. In this paper, we divide the image through processing of multiple threshold values into 5 × 5, and in the conventional method, carbon which can not be analyzed We were able to solve the calculation of fiber proportion and uniformity through image processing. In the order of this paper, the calculation method of the planar heating element, the calculation of the proportion of the carbon fiber of the planar heating element will be explained in the order of calculating the uniformity of the carbon fiber of the planar heating element, simulation, discussion and conclusion.

2. Materials and Methods

Carbon fiber is a material made of 100% carbon, heating carbon above 2700 degrees. High tensile strength is the main feature, it also has low electric resistance and it is used as a heating element. One advantage is that it has high emissivity as a heating element. On the other hand, the carbon fiber has a good characteristic of infrared radiation which shows 0.8 or more and shows up to 0.95 depending on the surface treatment, while the general metal wire emissivity is 0.3 or less. For these reasons, carbon fibers are continuously developed as highly efficient heating elements. In this research, carbon fibers were cut and used so that it was easy to unravel the developed fiber and to make a thin film. A carbon fiber nonwoven fabric capable of generating heat even at a lower voltage can be produced by configuring many contact points of the cut carbon fiber.

2.1. Dispersant.

Dispersing agent is dispersed in 12,000 strands to help disperse the carbon fiber in solution and effectively prevent aggregation of carbon fibers. Filtering requires the use of the least amount of technology, and to maximize productivity and price competitiveness, technology is needed to maximize the use of carbon fiber and to maximize dispersion. For dispersibility evaluation, a dispersion solution is prepared; carbon fiber is injected and loosened to make carbon fiber dispersion. Since it is necessary as a binder in the production of yarn-made carbon fiber nonwoven fabric, a sheet of a surface heating element can be prepared by injecting a dispersant and a binder. Figure 1.shows the process of making carbon fiber dispersion by making a dispersed solution and injecting and loosening carbon fiber.

Figure 1: Preparation of carbon fiber dispersion

2.2.1. Manufacture of Carbon Fiber Surface Heating Element

The carbon fiber sheet type surface heating element could be manufactured through the above three steps. The carbon fiber was made of nonwoven fabric using 6 mm carbon fiber and the thickness was 200μm. The fabricated carbon fiber sheet is 200x200mm in size and has a resistance of 2.9Ω / sq. The observation image of the heating state is a 300x300mm product. Figure 2.is a carbon fiber plane heating element manufactured by dispersion manufacturing, filter cloth and carbon fiber filtering.

Figure 2: Planar heating element in the form of nonwoven fabric

2.2. Calculation of Carbon Fiber Ratio

The planar heating element is characterized in that a metal electrode is placed on both ends of a thin planar conductive heating element as a new heat generating material of the heating system and then insulated with an insulating material to generate surface heat Heating body of a new concept created by technology. Unlike conventional heaters that generate heat from resistive wires, the heat chosen over the entire surface of the film is diverged, high thermal efficiency, energy saving effect, and because it is a carbon-based product, the generation of electromagnetic waves It can be minimized. The planar heating element can be divided into three types of planar heating elements of Full heating type, Partial heating type, Hot line type. In this paper, the proportion of carbon fibers of carbon fibers used for the front surface heating element is analyzed.Figure 3.shows the result of the insulation coating on carbon fiber nonwoven type surface heating element.

Figure 3: Carbon fiber planar heating element module

The method of proportion of the carbon fibers of the planar heating element is carried out through the following steps.
Step 1) Read the image of planar heating element of carbon fiber.
Step 2) Destroy the image of step 1) 25 pieces of 5 × 5. At this time, slight differences may occur depending on the size of the image of the last row and column images.
Step 3) the method of processing the global threshold value is

applied to the image of step 2). In this way, when the processing of the global threshold value is completed, the image of step 1) is converted into a binary image. Combine the image of carbon fiber with the image of step 3) in step 4) and divide it into the total of the whole images and calculate the proportion of carbon fibers from the surface heating element.

Figure 4: Image of 0.2 wt.% Carbon fiber in aqueous solution

Figure 5: Image of 0.4 wt.% Carbon fiber in aqueous solution

Figure 6: Image of 0.8 wt.% Carbon fiber in aqueous solution

Figure 7: Image of 2.4 wt.% Carbon fiber in aqueous solution

Figures 4 to 7 show the images of carbon fiber for 0.2 wt.%, 0.4 wt.%, 0.8 wt.% And 2.4 wt.% Of PVA aqueous solution.

2.3. Calculation of Uniformity of Carbon Fiber

The temperature of the surface heating element is determined by the applied voltage, the current flowing, and the uniform distribution of the carbon fibers. It is very difficult to mathematically model the surface heating elements to make them uniformly distributed. However, the influence of the distribution of carbon fiber on the temperature in the surface heating element can be confirmed through experiments.

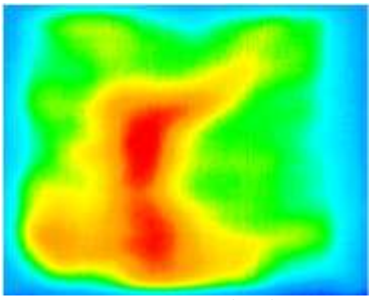

Figure 8: Temperature condition of surface heating element

Figure.8 shows the heat generation state of the planar heating element using an infrared camera. In the image of figure.8, it can be interpreted that heat generation is not displayed at the bottom. In this thesis, by calculating the uniformity numerically without experiment, it is possible to predict the position where the heat generation state is insufficient. Calculation of uniformity can be calculated by utilizing the proportion of carbon fiber proposed previously, and the equations used are the same as those in equations (8) to (10), and uniformity is given to two Calculated [11, 12].

$$X_{avg} = \frac{1}{25}\sum_{i=1}^{25} X_i \quad (1)$$

$$U_1 = \frac{X_{min}}{X_{max}} \times 100(\%) \quad (2)$$

$$U_2 = \{1 - \frac{X_{std}}{X_{avg}}\} \times 100(\%) \quad (3)$$

Where X_{std} is the standard deviation of the calculated ratio of carbon fibers.

3. Results and Discussion

Calculation of the uniformity of the planar heating element can be calculated using the ratio of the carbon fibers of the planar heating element. The calculation method is calculated by using the formulas (1) to (3), and the maximum proportion and the minimum ratio value are added and it is shown in Table 1.Figure must be of high resolution with printable

Table 1: Calculation of uniformity for plane heating elements

	Averagepercentage	Min percentage	Max percentage	Uniformity 1	Uniformity 2
0.2 wt.%	45.6%	34.85%	53.82%	64.75%	90.40%
0.4 wt.%	49.72%	38.28%	55.95%	68.42%	90.90%
0.8 wt.%	50.78%	25.19%	57.92%	43.49%	86.85%
2.4 wt.%	54.37%	49.55%	59.65%	83.07%	95.51%

In Table 1, the aqueous solution 0.2 wt. %, 0.4 wt. %, 0.8 wt. % And 2.4 wt. It shows uniformity of%. It can be confirmed that uniformity 1 and homogeneity 2 are displayed with high uniformity as the deviation of the minimum ratio and the maximum ratio from the average rate value is smaller. Aqueous solution 0.8 wt. Percentage was at least 25.19% and the maximum proportion was 57.92%, which was larger than other aqueous solutions, and as a result, it was calculated as 43.49% with uniformity 1 and 86.85% as the lowest as uniformity 2. Aqueous solution 2.4 wt. Percentage was at least 49.55%, the maximum proportion was 59.65%, the variation was the smallest compared to other aqueous solutions, and as a result, 80.07% at uniformity 1 and 95.51% at uniformity 2 were calculated highest.

4. Conclusion

In this paper, we proposed the development of calculation algorithms using image processing technology for proportion and uniformity of carbon fibers in planar heating elements. For the planar heating element, a sample fabricated with an aqueous solution (0.2 wt.%, 0.4 wt.%, 0.8 wt.%, 2.4 wt.%) Was used. Calculation of the proportion of carbon fiber was performed by applying a processing method of multiple threshold values to 25 images divided by 5 × 5 on the sample image and calculating the ratio. Calculation of the uniformity of carbon fibers from the surface heating element was calculated by ratio and two uniformity formulas. As a result, it was confirmed that the smaller the deviation between the maximum ratio and the minimum ratio, the higher the uniformity is displayed. Such an image analysis method of a planar heating element will be able to analyze the heat generation state more accurately by combining with an existing method.

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References

[1] A. Al-Ghamdi and F. E. Tantawy. (2010).Comp. Part A : Appl. Sci.Manuf. 41.
[2] Alan, M., Solid state lighting a world of expanding opportuities at LED 2002.(2003). Ⅲ-Ⅴs Review. 16(1). 30-33.
[3] R. Kim, H. K. Lee, S. H. Park, and H. K. Kim. (2011).Thin Solid Films. 519. 3496.
[4] C. Sun, T. X. Lee, S. H. Ma and S. M. Huand (2006)..Precise optical modeling for LED lighting verified by crosscorrelation in the midfield region.Optical Letters. 31(14).2193-2195.
[5] Y. Huang, W. W. Mo, and M. L. Roan. (2004). Surf. Coat. Tech., 184, 123.
[6] K Shinke, K Ando, T Koyama, T Takai, S Nakaji, T. Ogino. (2010). Properties of various carbon nanomaterial surfaces in bilirubin adsorption. , Colloids and Surfaces B: Biointerfaces. 77(1). 18-21.
[7] H. C. Chen, K. C. Lee and J. H. Lin. (2004). Electromagnetic and electrostatic shielding properties of co-weaving-knitting fabrics reinforced composites.Composites Part1, 35(1). 1249-1256.
[8] Rafael C. Gonzalez, Richard E. Woods. (2009).Digital Image Processing Using MATLAB 2nd ed
[9] Hideto Hashiguchi and HiasshiKimugasa.(1994). Electrical Resistivity of α-SiC Ceramics Added with NiO. J. Ceram. Soc. Japan, 102(2). 160-164.
[10] Mylene Brach, DilettaSciti, Andrea Balbo and AlidaBellosi,(2005). Short-Term Oxidation of a Ternary Composite in the System AlN-SiC-ZrB2. Journal of the European Ceramic Society, 25.1771-1780.
[11] Yuping, D., Shunhua, L. and Hongtao. G. (2005). Investigation of electrical conductivity and electromagnetic Shielding Effectiveness of polyaniline composites. Science and Technoly of Advanced Material, 1(1). 1-6.
[12] Diletta. Sciti, Cesare. Melandri and AlidaBellosi. (2004). Properties of ZrB2-Reinforced Tenary Composites. Adanced Engineering Materials, 6(9). 775-781.