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The Methodology of Image Processing in the Study of the Properties of Fiber as a Reinforcing Agent in Polymer Compositions

Vyacheslav V. Lyashenko
Laboratory "Transfer of Information Technologies in the risk reduction systems"
Kharkov National University of RadioElectronics
Kharkov, Ukraine

Valentin A. Lyubchenko
Department of Informatics
Kharkov National University of RadioElectronics
Kharkov, Ukraine

Mohammad Ayaz Ahmad
Physics Department
College of Science, University of Tabuk
Tabuk, Saudi Arabia

Alveera Khan
Physics Department, Motilal Vighyan Mahavidhyalaya,
Bhopal, India

Oleg A. Kobylin
Department of Informatics
Kharkov National University of RadioElectronics
Kharkov, Ukraine

Abstract: Fillers added to the matrix material help to enhance the properties of a composite. We reviewed the methodology of image processing in the study of polymer compositions. We have shown the need to apply the methodology of image processing in the study of polymer compositions. This allows you to improve the study of the properties of fiber as a reinforcing agent in polymer compositions.

Keywords: image processing, fiber, composite, segmentation, structure.

I. INTRODUCTION

The use of natural fiber as a reinforcing agent in polymer compositions is the basis of many studies for many years. As natural fibres are renewable in nature, so it can be a probable substitute for synthetic fibres in many applications where high strength is not needed. When compared to synthetic fillers such as glass, aramid, talc, and silica, natural fibres have a low density in many cases in comparison to synthetic fibres. Further, they do not leave any byproduct at the time of fabrication of composites because they are biodegradable in nature. It is not only ecofriendly but also cost effective and durable.

Yet, till date, example, the performance of coir fibre as a replacement in polymer composites has not proved satisfactory and comparable to other fibres [1]. But natural fibres may possibly replace synthetic fibres in many dedicate purposes, like where high strength and rigidity are not expected. It is known that investigators have done chemical modification of natural fibres in order to improve them with a polymer composite [2, 3, 4]. It has been illustrated that there are many factors that can change the properties of natural fibre reinforced polymer composites [5, 6, 7]. Due to this, it is essential to illustrate and record the properties of these fibres and investigate new source of applications of fibres in composites.

In the different studies, the main objective was to find effect of chemical treatment of natural fibre. It was also noted that the properties of fiber depends on its structure, changes in the morphology of fibre before and after treatment [1, 8]. To consider these questions can detail by using the procedure of image processing fiber. In the present study, the main objective consideration of the possibility of applying of the methodology of image processing in the study of the properties of fiber as a reinforcing agent in polymer compositions.

II. IMAGE PROCESSING AS AN ANALYSIS TOOL

Methodology processing of images, representing in general separate pictures of the individual perception of the reality, is one the areas of data mining and method for extracting additional information about processes under study. This is due to the fact that over 80% of information about the world around us, people tend to perceive by means of sight [9].

Standards of perception can be formed in systems similar to human sight, such as the video shooting, a photo or could be transformed in images of visual perception of the human by means of some technical device – for example, it can be roentgenograms, tomograph pictures and other pictures which are received with different special devices in optical or not in optical range. These circumstances impose certain features and restrictions, both on the nature of considered standards of perception, and on possibilities of their analysis, additional data accessing about outward things.

One can also talk about the variety of methods that form the basis of functioning of different computer vision system. In particular, there are methods of preliminary image processing (noise suppression, contrast increase, localization of separate sites of the image) [10, 11], methods of the

preliminary analysis (segmentation, contour allocation) [12, 13], cognitive processing recognition methods of the received information [14, 15] and methods of the formalized representation of the received visual patterns for their subsequent processing [16]. Nevertheless, despite the ability of using various methods processing and analysis of received visual image in different computer vision systems, one should consider both the specifics of how these images are displayed, as well as key tasks these computer vision systems fulfill.

It is connected with that the consideration of possibility of application of separate methods of analysis and image processing allows: to choose the most comprehensible methods of analysis and image processing for considered system of intellectual analysis of data; to optimize structure of considered system of intellectual analysis of data; to increase a productivity and an overall performance of concrete system of intellectual analysis of data.

The main task of application of the methodology of image processing in the study of the properties of fiber as a reinforcing agent in polymer compositions should be called clustering data (clustering of objects in the image). This will allow to realize various procedures of segmentation of images for their subsequent analysis and resulting of certain conceptual positions for acceptance of corresponding solutions on the basis of the analysis of incoming images.

This problem can be solved on the basis of:

the choice of markers for individual objects;

the detection of objects from an image;

the calculating the proportion of an object in the image.

Choice of markers and detection of objects from an image are based on identification of the object by color.

For calculating the proportion of an object in the image is used the formula:

$$v_i = \frac{s_i}{S} 100\% ,$$

where v_i – proportion i subjects in the image;

s_i – area of the i subjects in the image;

S – image area.

III. DATA FOR ANALYSIS

For analysis, we use images that are obtained by means of scanning electron microscopy. The scanning electron microscopy of the test samples were done by JSM 6390A (JEOL Japan). That is different portions of one sample, which is regarded (Fig. 1 and Fig. 2).

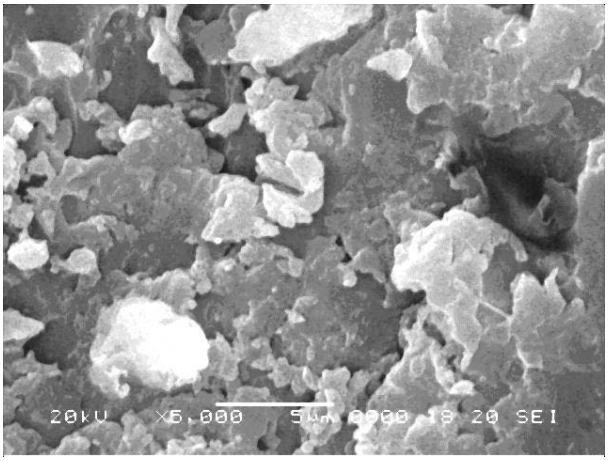

Fig. 1. The first part of the sample.

Images of the prepared samples were taken at the plane polished surface. One can notice from the above figures that there is change in the morphology of fibre. From of these images you can see, that cluster of fibre have inhomogeneous and deformed at microscopic level and therefore can be, for example, the reason for resistive ac conduction.

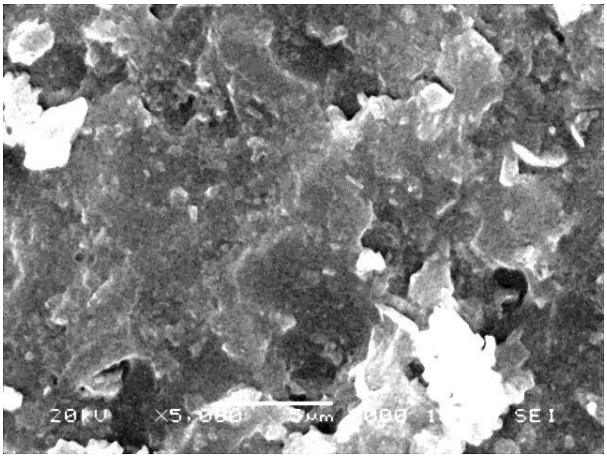

Fig. 2. The second part of the sample.

Uneven and cracked surface may be due to the presence of impurities in the fibre. We also see the crystalline nature of the fibre.

IV. IMAGE PROCESSING OF THE SAMPLES

We will consider four types of objects - bright objects (white color), of less than bright objects (gray color), less dark objects (dark gray color) and dark objects (black color).

We mark the examples of objects in each image. Then, we identify all objects in each image. Such identification is based on the segmentation of each image. We use the color segmentation.

On Fig. 3 example of color segmentation for image Fig. 1.

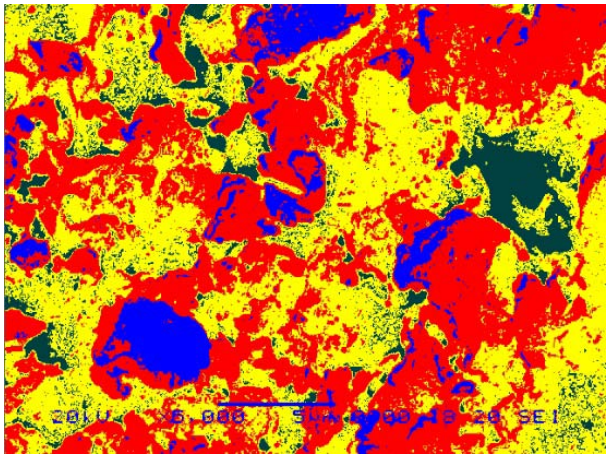

Fig. 3. Color segmentation for image Fig. 1.

Blue color segmented bright objects (see Fig. 1). Red color segmented of less than bright objects (see Fig. 1). Yellow color segmented less dark objects (see Fig. 1). Black color segmented dark objects (see Fig. 1).

From Fig. 3 we can see all uneven and cracked surface of the sample, which is studied.

Then we share the the selected objects. It is necessary to calculating the proportion of an object in the image.

On Fig. 4, Fig. 5, Fig. 6 shows the selected objects to Fig. 1.

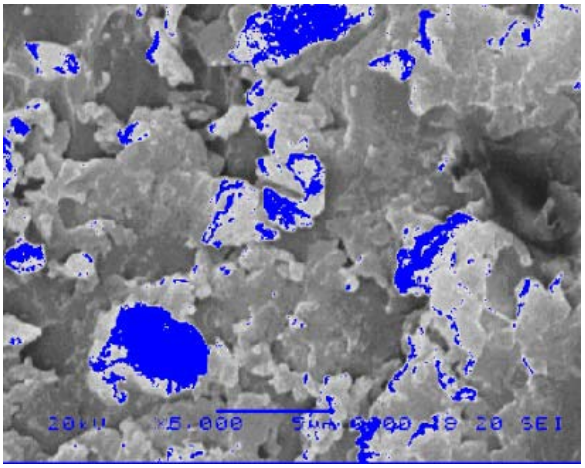

Fig. 4. Bright objects on Fig. 1

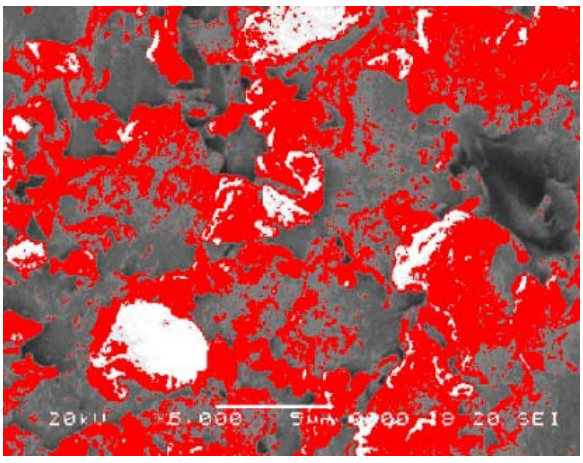

Fig. 5. Less than bright objects on Fig. 1

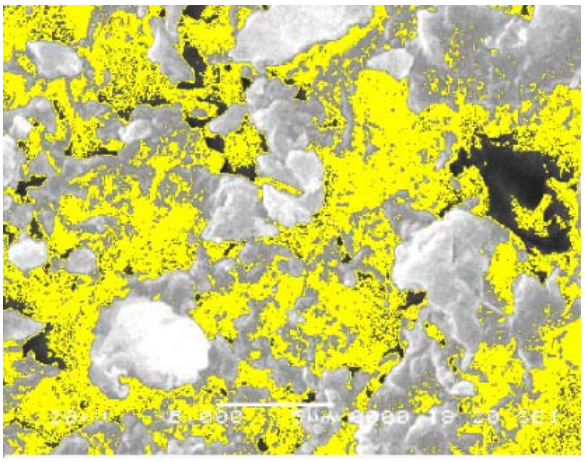

Fig. 6. Less dark objects and dark objects on Fig. 1

On Fig. 7, Fig. 8, Fig. 9 shows the selected objects to Fig. 2.

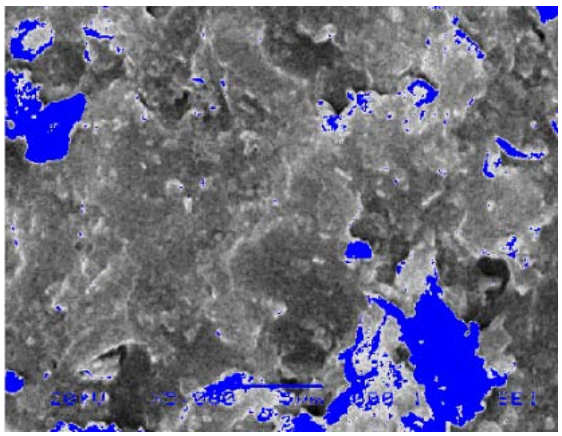

Fig. 7. Bright objects on Fig. 2

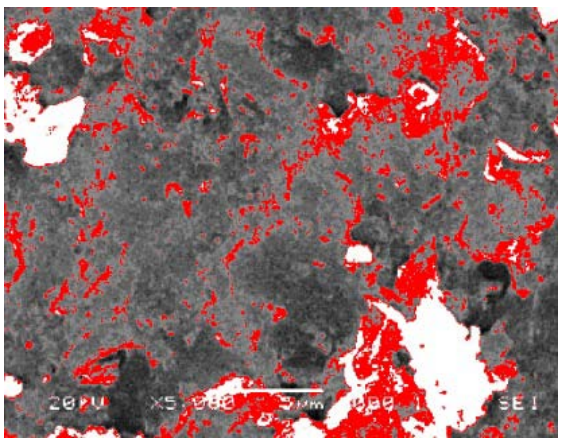

Fig. 8. Less than bright objects on Fig. 2

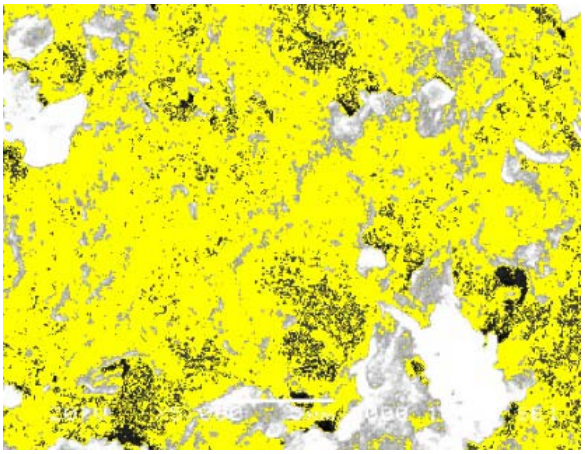

Fig. 9. Less dark objects and dark objects on Fig. 2

In Table. 1 shows the proportion of objects in the image to Fig. 1 and to Fig. 2.

Table. 1: Proportion of an object in the image.

Object type	Fig. 1	Fig. 2
bright objects	8%	9%
less than bright objects	44%	15%
less dark objects	39%	68%
dark objects	9%	8%

We see that the share of different objects varies from image to image. This can be the basis for explaining the properties of fiber as a reinforcing agent in polymer compositions.

V. CONCLUSIONS

We have considered the possibility of applying methodology of image processing in the study of the properties of fiber as a reinforcing agent in polymer compositions. This methodology is based on color segmentation of different types of objects in the image. This allows you to better see the uneven and cracked surface in polymer compositions.

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