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PROSPECTS OF SQUAREMETRICS FOR ESTIMATION OF SPONGE PRODUCTS POROSITY

At present there is a widespread use of computer technology to assess the quality of products from its image. Apart from the traditional color evaluation, this method can be used to analyze the morphology of the product surface, in particular for determining the porosity. In this paper we evaluated the possibility of using this method in the analysis of sponge products. An algorithm for the execution of research. Disadvantages of the method are indicated in the analysis of some specific types of products.

Introduction. During the recent years product quality research on the base of its digital image processing was widely spread.

In case of organoleprtic estimation such method allows conducting research more objectively and more accurately, which is particularly important by comparison of significantly different objects.

Besides, in some cases computer processing of an image can be applied at research of physical and chemical characteristics. Special meaning here belongs to analyses accompanied by decolorization. However, today such researches are done to estimate the structure of the product surface.

To receive digital images different equipment is used: web cameras, digital cameras, digital scanners. The latter have a lot of advantages – high quality of image at relatively low cost of equipment, automatic setting and colority calibration, high power of resolution.

Cellular products are widely applied: in technical aims (filters, isolating matters), in medicine, production of different household goods etc.

They can have different forms, colours, softness, density, porosity, but they all have pores. Cellular products can have interconnected or self-contained pores, the size of which is changing from ~ 0.4 μm to 0.2–0.4 mm.

Depending on the composition and peculiarities of technological process, pores interconnect or are isolated by thin walls.

Cellular rubber with big amount of interconnected pores has been long known as bath sponge, which is able to absorb a lot of water. Cellular (foam) rubber with small and medium-sized closed pores practically does not absorb water. It is used for sound and thermal isolation, vibration insulating gasket seal, draught excluders etc.

The character and size of pores depend on type of pore-forming materials, their use conditions and peculiarities of vulcanization process.

In estimation of cellular products quality estimation of pore size and porosity of the product in whole play important role.

Also among cellular products are expanded foam polyurethanes (foam polyurethane), which are widely used in household.

Main part. The aim of the research is study of possibility of use of computer scanometry to evaluate morphological traits of the product surface domestic yellow sponge with highly developed cellular structure was chosen.

We made research of porosity of a product's sample section. For morphological analysis of the section surface program ImageJ (imagej.ru) was used.

ImageJ (Image Processing and Data Analysis in Java) is a specially developed program to analyze medical and biological images. This program has open code and is freely spread.

ImageJ is a powerful drawing program for image processing and analysis. The campaign for ImageJ development was initiated by its creator Wayne Rasband in National Institutes of Health, USA.

To solve the task macros allowing automating the process of analysis and doing it according to developed research algorithm was scripted.

Algorithm of analysis (Fig. 1) consists of the following stages: sample scanning at digital scanner, input of scanned image to the program and its processing.

The flatbed scanner Hewlett Packard ScanJet 3,010 was used. Scanning was performed in True color mode with 1,200 dpi resolution. After saving, the image was transferred into the program ImageJ 1.45 for its processing. Then in the obtained image we allocated a plot of not less than 1200×1200 pix that corresponds to the actual size of 25.4×25.4 mm. That image was cut of the first processing operation is directed to a color correction, i.e.to convert image into a 8-bit format (Fig. 2) its color settings are reseted.

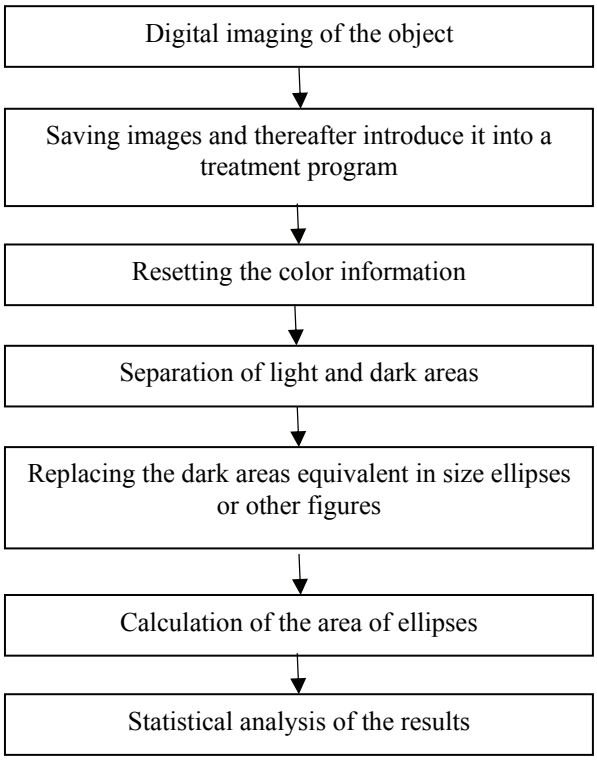

Fig. 1. Research algorithm

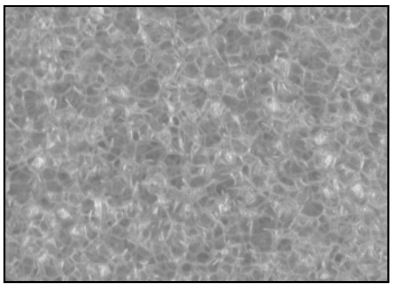

Fig. 2. 8 Bit image

After that division of areas for dark (pores) and light (non-porous material mass) is performed – thresholding (Fig. 3).

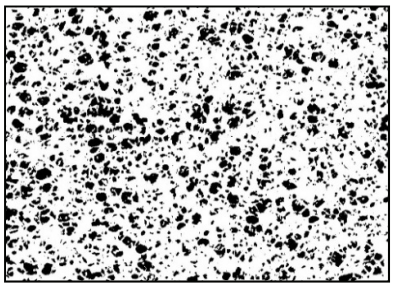

Fig. 3. View the image after treshholdinga

At the following stage the dark areas on the image are substituted by areally equivalent ellipses (Fig. 4).

Further processing is in calculating the ellipses content, which are in this parameter equal to each pore (these calculations are made by the program automatically, at that the resulting area is stated in square pixels).

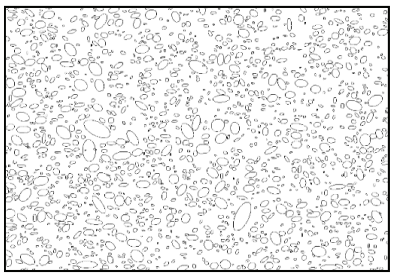

Fig. 4. View of the image after processing

If the scanning extension is known, one can easily switch the size in pixels to the utits of measure of pore size.

The final results processing and histograming of pore-size distribution was made with program data analysis package MS Excel 2010 (Fig. 5).

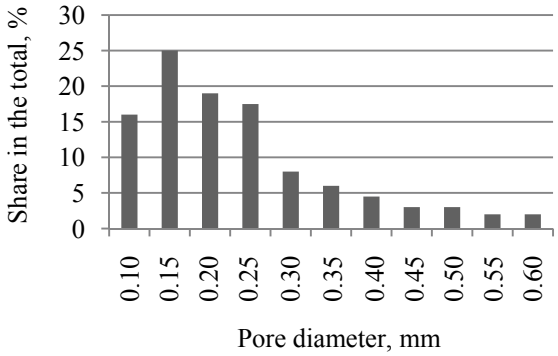

Fig. 5. Histogram of pore-size distribution

According to the results of the evaluation we can conclude that in the studied sample (domestic sponge) pores with diameter of 0.15–0.60 mm were found, at that the main mass of the pores (approximately 70%) has the size of 0.10–0.25 mm. The amount of pores with size more than 0.6 mm is not more than 1%.

The calculation of general porosity of the product is made on the base of the estimation of area under equivalent ellipses. In the studied sample this quantity makes 50.2%.

Conclusion. The received data on the base of the processing can be used to estimate the porosity structure (equal-unequal) and also for statement of amount and histograming of pore-size distribution.

At that this research methodic has a range of disadvantages. The main of them is that it is necessary to introduce correction factor for adequate estimation of general porosity. It is determined by the fact that in this methodic section of the product is researched, that means the estimation of porosity is made on the basis of the area of the pore without including its geometrical peculiarities (Fig. 6).

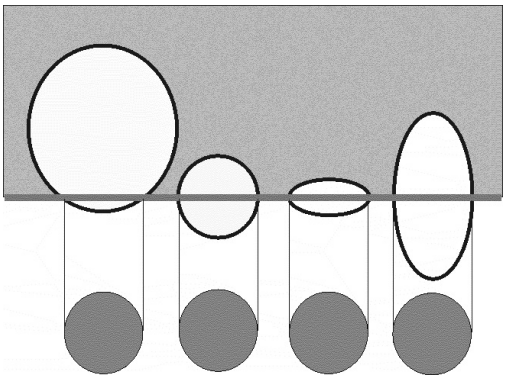

Fig. 6. Correlation of volume and area of pores depending on the pore's form

The research shows that this method is better for products with underdeveloped porosity. At that this method cannot be applicable for transparent products.

The lower detection limit is 10 pixels, which at the scanning extension of 1200 dpi is equivalent to a pore with diameter of 20 μm.

References

1. Рюткянен Е. А., Волин Ю. М., Корчемкин С. Н. Переработка и применение эластомеров. СПб: СПбГТИ(ТУ), 2010. 64 с.

2. Дементьев А. Г. Структура и свойства газонаполненных полимеров. М.: ВНИИСС, 1997. 409 с.

3. Сканерометрия – новый метод контроля качества пищевой продукции / О. В. Байдичева [и др.] // Пищевая промышленность. 2008, № 5. С. 20–22.

4. Прэтт У. Цифровая обработка изображений. М.: Мир, 1982. 781 с.

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