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Vector-matrix Analytical Model Recognitions of Nanoparticles of Silver on Polyester Fibers on Polarizing Raman Ranges

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Results of vector-matrix modeling of estimates of crossing of ellipses of distribution at recognition of nanoparticles of silver are given in polyair fibers on multidimensional correlation components of the Raman ranges with control according to polarizing characteristics. Reliability of recognition of nanoparticles was estimated on joint probability of normal distributions of intensivnost of the Raman spectrograms of nanoparticles of silver depending on longitudinal and cross polarization of laser radiation on all range of a range.

Keywords: Vector-matrix modeling, Polyester fiber, Silver nanoparticles, The Raman ranges, Polarizing characteristics of the Raman spectroscopy, Mathematical modeling of ranges, Multidimensional correlation components of the Raman ranges, Reliability of recognition, Probability of crossing of dispersions of normal two-dimensional distributions.

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1. INTRODUCTION

Recognition of particles of silver on polyester fibers requires the solution of system of the nonlinear analytical equations of the second order with 9 unknown parameters. It is connected with the fact that the Raman ranges of polyester fibers contain more than 9 information peaks. Sensitivity of usual recognition on amplitude of peaks on polyester fibers doesn't allow to estimate existence of nanoparticles of silver with rather acceptable reliability.

In the theory of recognition use only uncorrelated multidimensional details. It is connected with the fact that to identify correlation multidimensional parameters of object very difficult therefore go on the way of simplification of a problem, namely, accept the arrangement on noncorrelatedness of data in advance. Such simplifications facilitate approaches to a solution, but in a root don't provide her precision characteristics. Therefore the scientists who are engaged in recognition of objects even don't consider correlation data in recognition methods.

Correlation polarizing characteristics of the Raman spectroscopy allow to increase considerably reliability of recognition of the nanoparticles which are on fibers of fabrics.

In works [1-8] identification of nanoparticles on polyair fibers is estimated. But it is complicated to define the modes of drawing nanoparticles on fibers and especially their change at operation because of small quantity of such particles.

2. DESCRIPTION OF THE SUBJECT AND METHODS OF RESEARCH

2.1 Experimental Procedure

In this work the method of the vector-matrix decision of system of the nonlinear equations which are worked out on the basis of correlation data on object of system of a nanoparticle - polyester fiber is considered.

It isn't possible to make system of the equations of the second order with a large number of unknown to 9 in an analytical form because of a gromozdskost of an analytical look. Therefore an opportunity to use a vector-matrix form of record of system of the nonlinear quadratic equations and the decision of this system in the Mathcad programming environment is represented.

In this work the decision method only for system of quadratic equations with two unknown is fulfilled. Also the accuracy of the decision of system of the vector-matrix equations when comparing by 3 types of the solution of a task is estimated: with an analytical form of the decision of system of the equations, with experimental data at generation of correlation dependences and a manual method of search of crossing of ellipses of distribution in an analytical form.

For increase of reliability it is necessary to check still sufficiency of accuracy of coefficients of correlation in matrixes, and also the accuracy of population means and average quadratic deviations.

The offered researches allow to increase the accuracy of recognition of the fibers covered with nanoparticles of silver or uncovered nanoparticles according to polarizing characteristics of the Raman ranges with use of methods of a vector-matrix analytical assessment of crossing of ellipses of distribution of intensity of polarizing Raman ranges.

Carrying out statistical modeling of correlation parameters of intensity of ranges of fiber with silver nanoparticles is of considerable interest during operation at the decision of system of the equations of a vector-matrix analytical type of correlation ellipses of interdependent parameters with determination of coordinates of crossing.

Complexity of such modeling is represented in need of increase of accuracy of results of obtaining reliability of multidimensional correlation parameters. Complexity of such modeling is represented in need of increase of

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2.2 The Processing of the Experimental Data

Experiments on measurement of casual values of distribution of intensivnost of peaks of ranges of the Raman combinational radiation have been previously made, at the same time correlation matrixes are revealed rXY1, rXYAg9_0_8 and parameters of distributions population mean (MEN), average quadratic deviation ($\sigma\Delta$)taking into account polarization of radiation on X-across and on Y - along fibers at the same time for one measurement [9].

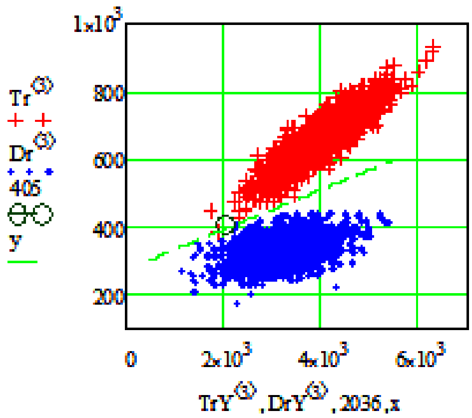
The analysis of the received results has shown that correlation matrixes have the big range of dispersion of values from 0.99868 to 0.24558 in the presence of silver nanoparticles, and for fibers without nanoparticles range from 0.812568 to – 0.340895.

Parameters of distributions, and, population means considerably differ on intensity of peaks of ranges with polarization across fibers X and along fibers Y. Along fibers intensity is much higher even several times both for fibers without nanoparticles, and for fibers with nanoparticles.

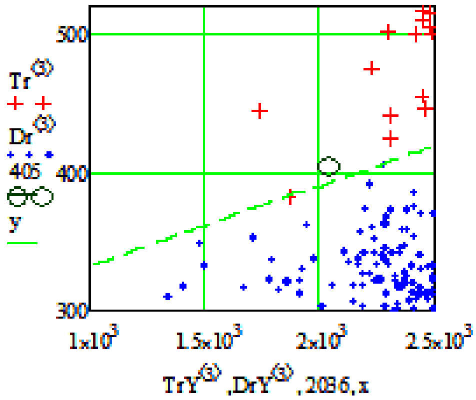
Characteristic is that at polarization along fibers intensity of the central peaks 4, 5, 6 and 7 is much higher than extreme peaks 1, 2, 3, 8 and 9 almost by 20 times. It indicates that maximum efficiency of measurements of the Raman ranges at polarization along fibers is found. However there is a task about check of informational content at measurement of peaks of polarizing ranges of the Raman radiation.

Modeling of statistical data for identification of crossings of ellipses of distributions of values of intensivnost of peaks of spectrograms has been carried out. Generation of the set amount of casual values was carried out according to the special program developed in the environment of MathCad Edition 14 [9-12].

The generated 1536 values of data for the 4th peak on an axis X and Y are given in figure 1a. Figure 1a and 1b shows that crossing of ellipses of distribution for



a



b

Fig. 1 – Two-dimensional correlation dependences of the Raman polarizing spectrograms of polyester fibers: a, b – a general view and the increased fragment at generation of data for the 4th peak

the 4th peak on 1 value of data happens in a point of $X_3 = 2036$ and $У_3 = 405$ to confidential probability $P4 = 1 - 1/1536 = 0.999348$.

Crossings of ellipses of distribution on figure 1 are found manually with подборм the number of the generated data.

For automatic identification of crossing it is necessary to solve system of the vector-matrix analytical equations and it will give coordinates of a point of intersection. In this work the system only of two vector-matrix equations is considered

$$R^2 = X^T \cdot \sum^{-1} \cdot X$$

3. DESCRIPTION AND ANALYSIS OF RESULTS

The analytical assessment of crossing of ellipses of distributions is made according to the decision of system of the vector-matrix equations with finding of coordinates of a point of intersection:

R:=4.2

$$\sum 0 := \begin{pmatrix} 1 & rXYAg9\_0\_8_3 \\ rXYAg9\_0\_8_3 & 1 \end{pmatrix} \quad (1)$$

$$\sum 1 := \begin{pmatrix} 1 & rXY1_3 \\ rXY1_3 & 1 \end{pmatrix} \quad (2)$$

$$f(x,y) := \left[\left(\frac{x - MENAg9_3}{\sigma\Delta XAg9_3} \quad \frac{y - MENAg9_3}{\sigma\Delta YAg9_3}\right) \cdot \sum 0^{-1} \cdot \begin{pmatrix} \frac{x - MENAg9_3}{\sigma\Delta XAg9_3} \\ \frac{y - MENAg9_3}{\sigma\Delta YAg9_3} \end{pmatrix}\right] \tag{3}$$

$$g(x,y) := \left[\left(\frac{x - MENX_3}{\sigma\Delta X_3} \quad \frac{y - MENY_3}{\sigma\Delta Y_3}\right) \cdot \sum 1^{-1} \cdot \begin{pmatrix} \frac{x - MENX_3}{\sigma\Delta X_3} \\ \frac{y - MENY_3}{\sigma\Delta Y_3} \end{pmatrix}\right] \tag{4}$$

x: = 480.0 y: = 3500.0

Given

f(x,y) = 0 g(x,y) = 0

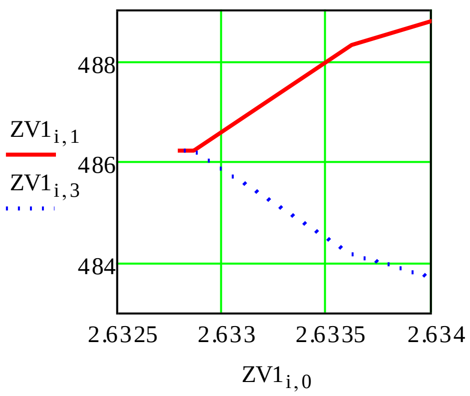
v: = Find(x,y)

$$v := \begin{pmatrix} 474.715302 \\ 2922778198 \end{pmatrix}$$

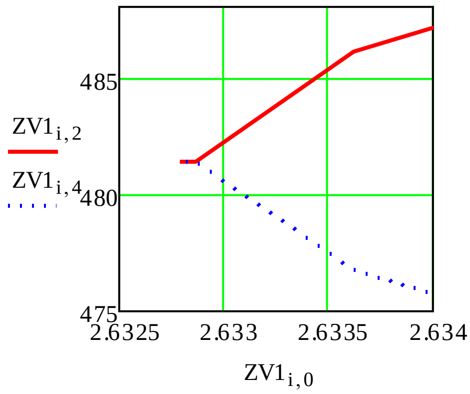
The decision of system of the vector-matrix equations (1-4) is made by criterion of crossing of ellipses not in two points, and in one for coordinates of extreme values $XV1_{(1)} = 486.178811$ and $XV1_{(2)} = 486.178808$ for RV1 = 2.6327965. For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) RV1 = 2.6328692 XV1 = 486.177701 on figure 2a and results of the decision (1-4).

For coordinate $YV1_{(1)} = 481.330075$ and $YV1_{(2)} = 481.330068$ for RV1 = 2.6327965 extreme value of crossing is revealed. At the beginning of double crossing the transition point from one point of intersection is revealed RV1 = 2.6328692 YV1 = 481.328982 on figure 2b and results of the decision (1-4).

The decision of system of the vector-matrix equations for the 4th peak is shown in figure 3a and 3b of and on digital results. Coordinates of extreme values $XV4_{(1)} = 405.802541$ and $XV4_{(2)} = 405.802526$ for RV4 = 3.5795803. For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) RV4 = 3.57959 XV4 = 405.802447 on figure 3a and results of the decision (1-4).



a



b

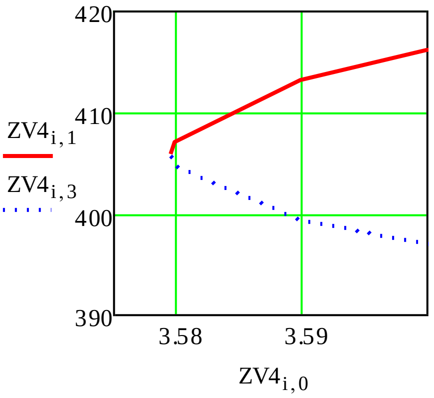
Fig. 2 – Images of crossings of ellipses of distribution by results of the decision of system of the analytical equations when crossing $XV1_{(1)}$, $XV1_{(2)}$ and $YV1_{(1)}$, $YV1_{(2)}$

$$ZV1 := \begin{pmatrix} 2.8284271 & 528.881098 & 567.397079 & 466.50686 & 419.022421 \\ 2.7568098 & 518.967917 & 548.460805 & 467.245771 & 428.143148 \\ 2.6832816 & 506.118037 & 523.180335 & 471.641128 & 444.879353 \\ 2.6683328 & 502.620537 & 516.13478 & 473.48887 & 450.26329 \\ 2.6532998 & 498.375443 & 507.449003 & 476.112918 & 457.326935 \\ 2.6457513 & 495.707274 & 501.901315 & 477.981469 & 462.078417 \\ 2.6381812 & 492.138552 & 494.353583 & 480.757906 & 468.839866 \\ 2.637423 & 491.673577 & 493.358002 & 481.144058 & 469.757365 \\ 2.6366646 & 491.170217 & 492.276776 & 481.568669 & 470.760607 \\ 2.6359059 & 490.616012 & 491.082044 & 482.044198 & 471.877456 \\ 2.6351471 & 489.989775 & 489.726418 & 482.591832 & 473.155297 \\ 2.634388 & 489.249474 & 488.115866 & 483.253606 & 474.688164 \\ 2.6336287 & 488.282254 & 485.997865 & 484.142372 & 476.728579 \\ 2.6328692 & 486.177701 & 481.328982 & 486.1777 & 481.32898 \\ 2.6327965 & 486.178811 & 481.330075 & 486.178808 & 481.330068 \end{pmatrix}$$

For coordinate $YV4_{(1)} = 2037.304707$ and $YV4_{(2)} = 2037.304497$ for RV4 = 3.5795803 extreme value of crossing is revealed. At the beginning of double crossing the transition point from one point of intersection is revealed RV4 = 3.57959 YV4 = 2037.0304042 on figure 3b and results of the decision (1-4).

4. CONCLUSIONS

Thus, at vector-matrix modeling of analytical crossing of ellipses of distribution with the decision of system of the equations (1-2) coordinates on 9 peaks are received:



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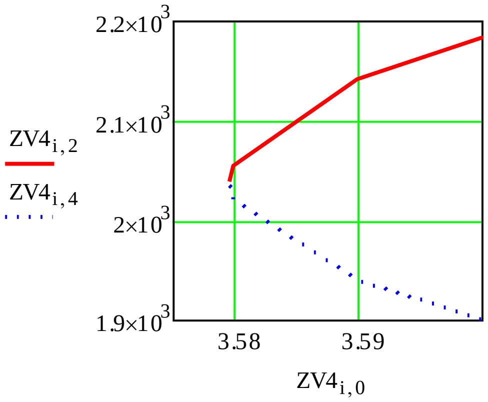

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Fig. 3 – Images of crossings of ellipses of distribution by results of the decision of system of the analytical equations when crossing XV4 $_{(1)}$, XV4$_{(2)}$ and YV4 $_{(1)}$, YV4$_{(2)}$

for cross polarization X ($ZV1_{i,1}$ и $ZV1_{i,3}$)

XVn^T = (486.179 192.216 267.413 405.80 474.45 566.05 654.178 349.53 697.07)

for longitudinal polarization Y ($ZV1_{i,2}$ и $ZV1_{i,4}$)

YVn^T = (481.3 373.02 771.516 2037.3 2731.06 1061.18 1214.3 105.58 154.19)

and the equivalent radius of curvature of ellipses when crossing

RVn^T = (2.633 1.463 2.537 3.580 2.403 3.336 2.241 3.255 3.122).

At an assessment of reliability of identification of nanosilver on fibers of polyair the following values for one-dimensional measurements on axis X in the cross direction of fiber are revealed:

for cross polarization of X

pX^T = (0.97917 0.92208 0.97917 0.99653 0.97917 0.99826 0.97917 0.98958 0.99479)

for longitudinal polarization of Y

pY^T = (0.78125 0.70833 0.77083 0.81250 0.77083 0.72917 0.79167 0.72917 0.87500)

and at two-dimensional measurement in cross X and longitudinal Y directions taking into account correlation coefficients:

pXY^T = (0.9896 0.92708 0.99306 0.99935 0.98611 0.99826 0.97917 0.99653 0.99479).

Thus, the offered method gives an essential prize in an assessment of reliability of definition of the modes of drawing nanoparticles of silver on fibers. So, for the 4th peak increase has happened more than by 1500 times.

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