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Short Communication

Assessment of Reliability of Recognition of Nanoparticles of Silver on Polyester Fibers on Two-dimensional Models and Experimental Data of the Raman Ranges

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Results of comparison of parameters of crossing of distribution of multidimensional correlation components of polarizing Raman ranges with control on polarizing characteristics at recognition of nanoparticles of silver are given in polyair fibers on vector-matrix modeling and generation of multidimensional correlation data. The assessment of reliability of recognition of nanoparticles was carried out on joint probability of normal distributions of intensivnost of the Raman spectrograms of fibers of polyair.

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 multidimensional distributions, Generation of multidimensional correlation data.

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1. INTRODUCTION

The Raman ranges of polyester fibers contain more than 9 information peaks. However 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.

It is considerable to increase reliability of recognition of the nanoparticles which are on fibers of fabrics, detection of correlation polarizing characteristics of the Raman spectroscopy allows.

In works [1-6] identification of nanoparticles is given in polyair fibers. But it is complicated to define the modes of drawing nanoparticles on fibers and especially change of quantity of particles at operation because of their small quantity.

In this work the method of vector-matrix drawing up analytical expressions and an assessment of equivalent radius of curvature on the basis of correlation data on object of system of a nanoparticle - polyester fiber is considered.

In view of a gromozdskost of an analytical type of system of analytical expressions of the second order with a large number of unknown to 9, in work it is offered to use a vector-matrix form of record of system of nonlinear quadratic expressions and further the decision of this system of the nonlinear quadratic equations in the Mathcad programming environment.

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 the parameters of crossing of distribution of intensity of polarizing Raman ranges.

2. DESCRIPTION OF THE SUBJECT AND METHODS OF RESEARCH

2.1 Experimental Procedure

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 [7].

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 [7-10].

2.2 The Processing of the Experimental Data

For identification of R – the radius of curvature of ellipses of crossing of the generated data it is necessary to write down it in vector-matrix analytical expressions on coordinates of points of intersection. In this work the system only of two vector-matrix analytical expressions is considered

$$R^2 = X^T \cdot \sum{}^{-1} \cdot X \text{ for } R_0 \text{ and } R_1.$$

The analytical assessment of R0 and R1 – curvature radiuses on points of intersection of ellipses of distributions is made on vector-matrix analytical expressions (1-2):

$$R0 := \left[\left(\frac{401.42 - MENAg9_3}{\sigma\Delta XAg9_3} \quad \frac{2005.9 - MENAg9_3}{\sigma\Delta YAg9_3} \right) \cdot \sum 0^{-1} \cdot \begin{pmatrix} \dfrac{401.42 - MENAg9_3}{\sigma\Delta XAg9_3} \\ \dfrac{2005.9 - MENAg9_3}{\sigma\Delta YAg9_3} \end{pmatrix} \right] \quad (1)$$

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$$\mathrm{R1} := \left[\left(\frac{401.42 - \mathrm{MEX}_3}{\sigma\Delta X_3} \quad \frac{2005.9 - \mathrm{MENY}_3}{\sigma\Delta Y_3} \right) \cdot \sum 1^{-1} \cdot \begin{pmatrix} \frac{401.42 - \mathrm{MENX}_3}{\sigma\Delta X_3} \\ \frac{2005.9 - \mathrm{MENY}_3}{\sigma\Delta Y_3} \end{pmatrix} \right] \quad (2)$$

$$R_0 = 12.455609107$$

$$\sqrt{R_0} = 3.5292505022$$

$$R_1 = 13.3038634609$$

$$\sqrt{R_0} = 3.647446156$$

Probability density for a point of intersection of ellipses of distribution of intensivnost of reradiation of the Raman ranges is specified in expressions (3-4):

$$\mathrm{p0} := \frac{1}{(2\cdot\pi)\cdot\left[\left[1-\left(\mathrm{rXYAg9\_0\_8}_{3,3}\right)^2\right]^{0.5}\right]}\cdot e^{\frac{-R0}{2}} \quad (3)$$

$$\mathrm{p1} := \frac{1}{(2\cdot\pi)\cdot\left[\left[1-\left(\mathrm{rXY1}_{3,3}\right)^2\right]^{0.5}\right]}\cdot e^{\frac{-R1}{2}} \quad (4)$$

$p_0 = 3.525\cdot10^{-4}$ $p_1 = 9.892\cdot10^{-4}$

3. DESCRIPTION AND ANALYSIS OF RESULTS

At vector-matrix modeling of analytical crossing of ellipses of distribution coordinates on 9 peaks are received.

When comparing with experimental data when modeling with use of generation of multidimensional correlation dependences of coordinate of crossing of ellipses of distribution following:

for cross polarization of X

$XEn^T = (508.31 \;\; 187.17 \;\; 269.05 \;\; 401.42 \;\; 477.04 \;\; 551.12 \;\; 670.90 \;\; 334.39 \;\; 712.03)$

for longitudinal polarization of Y

$YEn^T = (590.97 \;\; 558.13 \;\; 827.27 \;\; 2005.9 \;\; 2945.7 \;\; 1138.8 \;\; 1318.1 \;\; 133.93 \;\; 166.18)$

Equivalent radius of ellipses when crossing for fiber without nanoparticles

$R0En^T = (2.281 \;\; 2.829 \;\; 2.417 \;\; 3.529 \;\; 2.399 \;\; 2.714 \;\; 2.453 \;\; 2.578 \;\; 3.436)$

and the equivalent radius of ellipses when crossing for fiber with nanoparticles

$R1En^T = (4.679 \;\; 4.232 \;\; 2.795 \;\; 3.647 \;\; 3.060 \;\; 4.015 \;\; 2.704 \;\; 5.646 \;\; 2.774)$

At the choice of points of intersection of the ellipses of distribution constructed on population means, average quadratic deviations and correlation coefficients with selection of equivalent radius of ellipses of distribution crossing coordinates are received:

for cross polarization of X

$XPn^T = (488.20 \;\; 192.22 \;\; 267.37 \;\; 409.82 \;\; 474.45 \;\; 565.68 \;\; 654.19 \;\; 349.52 \;\; 697.07)$

for longitudinal polarization of Y

$YPn^T = (486.00 \;\; 373.44 \;\; 770.96 \;\; 2095.7 \;\; 2731.2 \;\; 1059.1 \;\; 1214.3 \;\; 105.60 \;\; 154.13)$

and the equivalent radius of curvature of ellipses when crossing

$RPn^T = (2.636 \;\; 1.463 \;\; 2.538 \;\; 3.584 \;\; 2.40 \;\; 3.335 \;\; 2.241 \;\; 3.255 \;\; 3.122)$.

For a point of intersection of ellipses of distribution at the radius of R0En and R1En probability density on (3-4) are estimated

$p1^T = (1.337\cdot10^{-5} \;\; 3.17\cdot10^{-5} \;\; 0.0105 \;\; 9.89\cdot10^{-4} \;\; 7.99\cdot10^{-3} \;\; 1.404\cdot10^{-4} \;\; 0.0327 \;\; 4.094\cdot10^{-8} \;\; 7.36\cdot10^{-3})$

$p0^T = (0.0142 \;\; 2.91\cdot10^{-3} \;\; 8.95\cdot10^{-3} \;\; 3.52\cdot10^{-4} \;\; 9.014\cdot10^{-3} \;\; 4.73\cdot10^{-3} \;\; 7.85\cdot10^{-3} \;\; 5.758\cdot10^{-3} \;\; 4.35\cdot10^{-4})$

Average values of density of probability on p1 and p0 will be

$p^T = (7.107\cdot10^{-3} \;\; 1.471\cdot10^{-3} \;\; 9.725\cdot10^{-3} \;\; 6.71\cdot10^{-4} \;\; 8.5\cdot10^{-3} \;\; 2.43\cdot10^{-3} \;\; 0.02 \;\; 2.88\cdot10^{-3} \;\; 3.897\cdot10^{-3})$.

Probabilities of crossing of ellipses of distribution on peaks of ranges for nanofibre with nanoparticles

$Q1^T = (0.99998 \;\; 0.99997 \;\; 0.98949 \;\; 0.99901 \;\; 0.99280 \;\; 0.99986 \;\; 0.96727 \;\; 0.99999 \;\; 0.99263)$

and for fiber without nanoparticles

$Q0^T = (0.98582 \;\; 0.99708 \;\; 0.99105 \;\; 0.99965 \;\; 0.99099 \;\; 0.99527 \;\; 0.99215 \;\; 0.99424 \;\; 0.99956)$

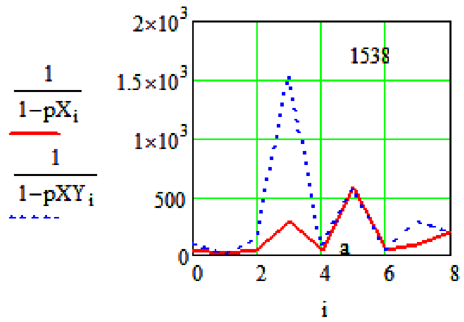
Average values of probability of crossing of ellipses of distribution following:

$Q^T = (0.99290 \;\; 0.99853 \;\; 0.990275 \;\; 0.99933 \;\; 0.99154 \;\; 0.99756 \;\; 0.97971 \;\; 0.99712 \;\; 0.99609)$

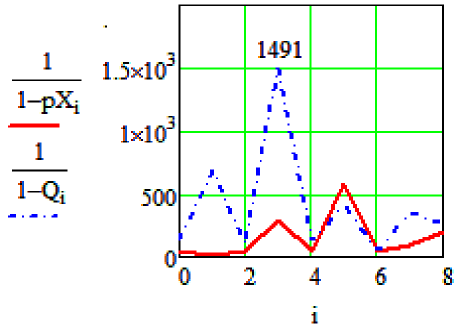
4. CONCLUSIONS

In figure 1 the comparative analysis of increase of informational content of an assessment of reliability is submitted.

At the same time in figure 1a, the continuous line has presented measurements at cross polarization of X with generation multidimensional correlation data; and dotted – in figure 1a – measurements in cross X and longitudinal Y directions taking into account coefficients of correlation and equivalent radius of an ellipse in a point of intersection of ellipses, in figure 1b –



a



b

Fig. 1 – Increase of informational content of an assessment of reliability at application of two-dimensional measurement

measurements in cross X and longitudinal Y directions taking into account coefficients of correlation and density of probability in a point of intersection.

The analysis of results of research has shown that 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, increase in reliability on equivalent radius произощдо by 1521 times, and on probability density – by 1491 times.

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