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

V.M. Emelyanov*, T.A. Dobrovolskaya, S.A. Danilova, V.V. Emelyanov, K.V. Butov,

Southwest State University, 94, 50 Let Octyabrya st., 305040 Kursk, Russia

(Received 04 May 2016; published online 03 October 2016)

Results of vector-matrix modeling of estimates of crossing of ellipses of distribution at recognition of nanoparticles of silver are given in polair 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.

DOI: 10.21272/jnep.8(3).03002 PACS numbers: 02.60.Cb, 02.70.Rr

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 polair 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 nanoparticiles 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
accuracy of results of obtaining reliability multidimensional correlation the parametровни is represented in need of increase of accuracy of results of obtaining reliability of multidimensional correlation parameters.

2.2 The Processing of the Experimental Data

Experiments on measurement of casual values of distribution of intensiveness of peaks of ranges of the Raman combinational radiation have been previously made, at the same time correlation matrixes are revealed rXY, rXYAg9,0_8 and parameters of distributions population mean (MEN), average quadratic deviation (σΔ) 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 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 is made according to the decision of system of the vector-matrix analytical equations with finding of coordinates of a point of intersection:

\[ R^2 = X^T \Sigma^{-1} X \]

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:

\[
\sum 0 := \begin{pmatrix} 1 & rXYAg9_0_8 \\ rXYAg9_0_8 & 1 \end{pmatrix} \quad (1)
\]

\[
\sum 1 := \begin{pmatrix} 1 & rXYl3 \\ rXYl3 & 1 \end{pmatrix} \quad (2)
\]
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 \( \text{XV}_{1(1)} = 486.178811 \) and \( \text{XV}_{1(2)} = 486.178808 \) for \( \text{RV}_1 = 2.6327965 \). For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) \( \text{RV}_1 = 2.6328692 \). \( \text{XV}_1 = 486.177701 \) on figure 2a and results of the decision (1-4).

For coordinate \( \text{YV}_{1(1)} = 481.330075 \) and \( \text{YV}_{1(2)} = 481.330068 \) for \( \text{RV}_1 = 2.6327965 \) 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 \( \text{XV}_{4(1)} = 405.802541 \) and \( \text{XV}_{4(2)} = 405.802526 \) for \( \text{RV}_4 = 3.57595803 \). For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) \( \text{RV}_4 = 3.575959 \). \( \text{XV}_4 = 405.802447 \) on figure 3a and results of the decision (1-4).

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 \( \text{XV}_{1(1)} = 486.178811 \) and \( \text{XV}_{1(2)} = 486.178808 \) for \( \text{RV}_1 = 2.6327965 \). For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) \( \text{RV}_1 = 2.6328692 \). \( \text{XV}_1 = 486.177701 \) on figure 2a and results of the decision (1-4).

For coordinate \( \text{YV}_{1(1)} = 481.330075 \) and \( \text{YV}_{1(2)} = 481.330068 \) for \( \text{RV}_1 = 2.6327965 \) 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).

**Fig. 2** – Images of crossings of ellipses of distribution by results of the decision of system of the analytical equations when crossing \( \text{XV}_{1(1)}, \text{XV}_{1(2)} \) and \( \text{YV}_{1(1)}, \text{YV}_{1(2)} \).

For coordinate \( \text{YV}_{4(1)} = 2037.304707 \) and \( \text{YV}_{4(2)} = 2037.304497 \) for \( \text{RV}_4 = 3.5795803 \) 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:
Fig. 3 – Images of crossings of ellipses of distribution by results of the decision of system of the analytical equations when crossing XV4 (a), XV4(b) and YV4(a), YV4(b) for cross polarization X (ZV4i,0)

REFERENCES