Development of a Technique of an Analytical Assessment of Crossing of Ellipses of Distribution on Polarizing Raman Ranges at Identification of Nanoparticles on Silver Fibers

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(Received 28 September 2015; published online 10 December 2016)

Analytical estimates of crossing of ellipses of distribution at recognition of nanoparticles of colloidal silver are given in polar yarn 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 on polar fibers depending on longitudinal and cross polarization of laser radiation on all range of a range with the analysis of 9 main peaks.

Keywords: Polyester fiber, Nanoparticles of colloidal silver, The Raman ranges, Polarizing characteristics of the Raman spectroscopy, Mathematical modeling of ranges, Multidimensional correlation components of the Raman ranges, Reliability of recognition.

PACS numbers: 02.60.Ch, 02.70.Rr

1. INTRODUCTION

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 [1-7] identification of nanoparticles on polya- yarn fibers is estimated. But to define the modes of drawing nanoparticles on fibers and especially their change at operation it is complicated because of their small quantity.

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

2. DESCRIPTION OF THE SUBJECT AND METHODS OF RESEARCH

2.1 Experimental Procedure

In Fig. 1 it is visible that korellyatsionny matrixes have the big range of dispersion of values from 0.99868 till 0.24558 in the presence of nanoparticles of silver (fig. 1a), and for fibers without nanoparticles range from 0.81258 to 0.340895.

Parameters of distributions (1), 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 and 7 is much higher than extreme peaks 1, 2, 3, 8 and 9 almost by 20 times. It specifies 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.

\[
\text{MENX}^2 = (698.207 \times 266.156 \times 384.805 \times 659.824) \times 661.582 \times 489.924 \times 412.999 \times 796.091),
\]

\[
\text{MENY}^2 = (84.487 \times 50.527 \times 47.174 \times 73.693 \times 77.891 \times 89.624 \times 87.343 \times 16.679 \times 31.712),
\]

\[
\text{MENZ}^2 = (745.167 \times 457.096 \times 1196.862 \times 4023.730
\]

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2.2 The Processing of the Experimental Data

We will carry out modeling of statistical data for identification of crossings of ellipses of distributions of values of intensivnest of peaks of spectromgrams. We will create the general correlation matrix for full generation of data on the basis of initial matrices of Fig. 1 and we will receive a correlation matrix of RXY1 with a general size of 38 × 38.

Generation of the set amount of casual values is carried out in normal way to the law and a matrix of RXY1 for what the built-in MathCad Edition 14 [4-6] function is used. Further we define a vector of own numbers from the general correlation matrix of RXY1.

As the generated casual values possess some correlation which is negatively affecting modeling accuracy, it is necessary to lead them to an uncorrelated look for what the special program developed in the environment of MathCad Enterprise 11 is used. The data of modeling received by such transformation possess the correlation aspiring to zero.

Further we will transform uncorrelated values through a fundamental matrix of UR of a correlation matrix of RXY1 to the correlated.

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

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

\[ r_{XY1} = 0.97817; \quad r_{XYAG_9_0_8_5} = 0.453528; \]
\[ f(x,y) = \frac{(x-MEXAg9_9)(x-MINAg9_9)^2 - 2 \cdot (x-MEXAg9_9)(y-MINYAg9_9)(x-MYAg9_9) + (y-MINYAg9_9)2}{(x-MEXAg9_9)^2 - 2 \cdot (x-MEXAg9_9)(y-MINYAg9_9)(x-MYAg9_9) + (y-MINYAg9_9)2}; \]
\[ g(x,y) = (x-MEXAg9_9)(x-MEXAg9_9)^2 - 2 \cdot (x-MEXAg9_9)(y-MINYAg9_9)(x-MYAg9_9) + (y-MINYAg9_9)2}; \]
\[ x = 400; \quad y = 2000; \quad f(x,y) = 0; \quad g(x,y) = 0; \]
\[ f(v_1, v_2) = 7.127 \times 10^{-5}; \quad g(v_1, v_2) = 8.997 \times 10^{-4}. \]  

The decision of system of the analytical equations (2) is made by criterion of crossing of ellipses not in two points, and in one for coordinates of limit values \( X(0) = 485.948874 \) and \( X(2) = 485.948889 \) for Ro2 = 4.17321043. For double crossing of ellipses of distribution the transition point from one crossing is revealed (only contact) \( R^2 = 4.1733 X_0 = 486.01424. \)

For coordinate \( X(1) = 481.103016 \) and \( Y(2) = 481.109048 \) for \( R^2 = 4.17321043 \) limit value of crossing is revealed. At the beginning of double crossing the transition point from one point of intersection is revealed \( R^2 = 4.1733 Y_0 = 481.16753. \)

Coordinates of limit values \( X_{(3)} = 485.948874 \) and \( Y_{(2)} = 2036.720505 \) for \( R^2 = 4.3.201055 \) limit value of crossing is revealed. At the beginning of double crossing the transition point from one point of intersection is revealed \( R^2 = 4.3.2027 Y_3 = 2037.098168. \)

3. DESCRIPTION AND ANALYSIS OF RESULTS

At an analytical assessment of crossing of ellipses of distribution with the decision of system of the equations coordinates on 9 peaks are received:

- for cross polarization of \( X \)
  \[ XAn^4 = (485.949 192.204 267.401 405.702 474.262 566.027 653.626 349.531 695.899); \]  
  (3)

- for longitudinal polarization of \( Y \)
  \[ YAn^3 = (481.103 373.014 771.483 2036.72 2729.72 1061.13 1212.73 105.587 153.743); \]  
  (4)

- and the equivalent radius of curvature of ellipses when crossing
  \[ RAn^2 = (2.632 1.463 2.537 3.578 2.399 3.366 2.234 3.255 3.159); \]  
  (5)

In comparison 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 \( X \)
  \[ X\tilde{n}^4 = (508.31 187.17 269.05 401.42 477.04 566.027 653.626 349.531 695.899); \]  
  (6)

- for longitudinal polarization of \( Y \)
  \[ Y\tilde{n}^3 = (601.12 670.90 334.39 712.03); \]  

Fig. 2 - Increase of informational content of reliability when using two-dimensional measurement in cross X and longitudinal At the directions taking into account correlation coefficients: __ measurements at cross polarization of X, .... measurements in cross X and longitudinal At the directions taking into account correlation coefficients

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At a 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
\[ Xp^2 = (488.20 \ 192.22 \ 267.37 \ 409.82 \ 474.45 \ 565.68 \ 654.19 \ 349.52 \ 697.07) \]  
(8)

for longitudinal polarization of Y
\[ Yp^2 = (486.00 \ 373.44 \ 770.96 \ 2095.7 \ 2731.2) \]  
(9)

and the equivalent radius of curvature of ellipses when crossing
\[ RPn^2 = (2.636 \ 1.463 \ 2.538 \ 3.584 \ 2.403 \ 3.335 \ 2.241 \ 3.255 \ 3.122). \]  
(10)

4. CONCLUSIONS

The method giving substantial increase estimates reliability of definition of the modes of drawing nanoparticles of silver on fibers that illustrates Fig. 2 was as a result offered.

REFERENCES