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Information Technology of Laser Measurement System Creation for Automated Control Dynamics of Glue Drying in Polygraphy

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Abstract — **The article considers technology of laser systems and information technology combination for concentration measurement constructing for evaluating the parameters of liquids evaporation in the process of printing products and adhesive drying.**

Keywords — *combitates system; information tecnology; chemistry; laser; resonance phenomena; quantum interaction; concentration; drying; glue.*

I. Introduction

Statement of a problem. The problem of estimation of chemical concentration in the air and solutions used in the technological processes of energetics, printing, food industry, oil and gas industry is very actually for now. This causes the research complexity of such processes by structure and components. The reverse task of estimating the water concentration in the components used in the technological processes of printing production is also relevant. Without using computer systems, we cannot to evaluate received information in real-time and make necessary decision about technological processes. An important task of management is studying the solubility of chemical elements in glues and the dynamics of their evaporation in the process of drying the printing products with the help of laser activation and remote control of the concentration evaporation level of the chemical components. All information from the sensors evaluated by specialized laser-information system. The basis of the proposed technology is the combination of laser systems and information technology (for laser control and processing of the data).

Analysis of recent research and publications. Solutions to improve the accuracy and stability of optical measuring systems (analyzers) on the basis of information and system technologies. In the works [8-12] the basic concepts of spectrometric methods of analysis for solving a wide class of problems of control in technical systems and the biophysical and chemical reactors are examined. In the work [11] principles of laser synthesis of information-measuring systems (IMS) for monitoring and control of technological processes with high temperature environments are justified. This shows the effectiveness of laser sensing to a broader class of technologies, especially for studies of the dynamics of chemical reactions. In [12] the optical properties of chemical solutions and was conducted the substantiation for spectral research methods for photoactive environments and structures photometers are considered. Accordingly, in [3] the application of the methods of photoelectron spectroscopy in chemistry to obtain structural information, quantitative analysis, evaluation of chemical shifts, adsorption are considered. Deep analysis of design methods of optoelectronic systems considered in [1-5], but the problem of laser systems synthesis (with computer data-analyzer) was not consider.

The purpose of the article. Development of methods and tools (based in information technologies) for the rapid assessment of the concentration level of the component in the process of book blocks drying is an important task [1-8].

II. Method of Solving the Problem

While sensing for solutions of glue, which can have both active and passive (absorbing) medium, respectively, occur the following processes (if the laser power is sufficient for the excitation of molecules):

- absorption and scattering of the laser beam in a cuvette with a liquid in which the particles of the solid component with mass m_k mass are hung, and the output signal of the photo detector will then be (1)

$$U_I(c_r) = \mu_v k_s I(c_{r_i}, \tau, \theta) = = \mu_v k \int_{S_{FP}} W\big(I(x, y, t / c_r)\big) ds \tag{1}$$

  being $W\big(I(x, y, t / c_r)\big)$ – density function of power distribution of the beam , $W_Y(\ )$ – distribution function scattering;

- amplification of the laser signal due to the nonlinear effect of the molecular orbitals excitation of the active component in the solution (2)

$$U_I(c_r,\theta,t) = \\ = \mu_u k_s (1+k_A) \int_{S_{FP}} W\left(I\left(x,y,t/c_r^A\right)\right) ds \quad (2)$$

being k_A – the coefficient of active amplification due to the resonance with the frequency of the laser beam, S_{FP} – the area of the photo detector;

- when sensing optically transparent objects have the absorption of the laser beam in the solid sections of the component object of study.

Amplification of laser signal due to the centers of activation when they are excited by laser pulses in the direction of the laser beam (3):

$$I(x,L) = \left(1+k_A(L,\theta)\right) \int_{S_{FP}} W_S\left(I\left(x,y,t/\tau_L,\theta\right)\right) ds \quad (3)$$

being τ_L – the transmittance when the thickness of the slice L of the research object; $k_A(L,\theta)$ – the coefficient due to nonlinear effects at resonance with the frequency of the laser beam, $W_S(\ )$ – the transfer function of the medium volume V_S.

According to the analysis above, the scheme of the laboratory system for concentration measurement is developed, which can be used for studies of solutions and for saturated vapors technological environment.

A review of the various methods of chemical analysis and photometry have shown that for solving problems of this class it is necessary to use methods of laser photometry, because they are subject to high mobility. The reason for the proliferation of laser methods was that gas lasers were large and required large power sources of energy. The emergence of semiconductor lasers of low and medium power provided the possibility of their use in Photonics and photometry.

In the experimental assessment of the solubility dynamics of the glue using a laser sensing component is described in a fixed solution and actually simulates an impulsive perturbation of the fluid in the cell, which is in the process of changing the solubility concentration of the liquid medium of the glue. Accordingly, the equation of dynamics change of concentration would be (in the formation of the glue) (4):

$$\dot{X}_j = F_j(X_i) + \frac{1}{\tau}\left(X_j^0 - X_j\right), i,j \in N \quad (4)$$

being X_j^0 – the initial concentration of the substance τ – the time constant of the reactor cell $(\tau = Q_R / V_q)$ – where Q_R the volume of the cell V_q – mass velocity.

$$Vqcr(T-T_0) - U(T'-T) = \\ = \left[V_R\left(\Delta Hp\exp(-E/RT)\right)\right] + \\ + \left[VqX_0\left(Vq + V_R p\exp(-E/RT)\right)\right.$$

being V_q – the mass flow rate of concentration, heat, r – density of the reactant, X – is the concent the temperature, $U = S_n / RT$ – coefficient of hea flow, V_R – reactor volume, H – heat of reaction (er

The process of the chemical component solu glue is characterized by certain chemical char structure of the component reactants to a level req technological process of drying of printing product

- molecular;
- ionic $\left[(KX_1 + H_2O) \rightleftarrows K^+(H_2O)_n + A^-(H_2O)_n\right.$
- complex components with highly dispersed

III. Laser Activation of The Printing Pr Drying Process

The action of a laser beam also undergoes mo decay of the species $[ABC + H\gamma \rightarrow AB + C]$ stimulation of chemical reactions due to io dissociation of excitation of electronic and oscillations in resonance and nonresonance modes

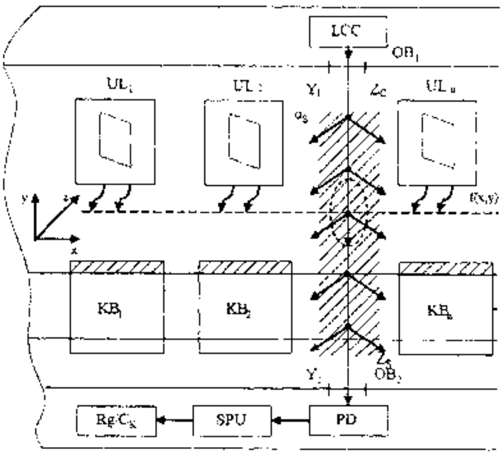

Fig. 1. Information technology of combining laser and info for drying process activation and laser control of the c chemical compounds emissions during the drying of printing p

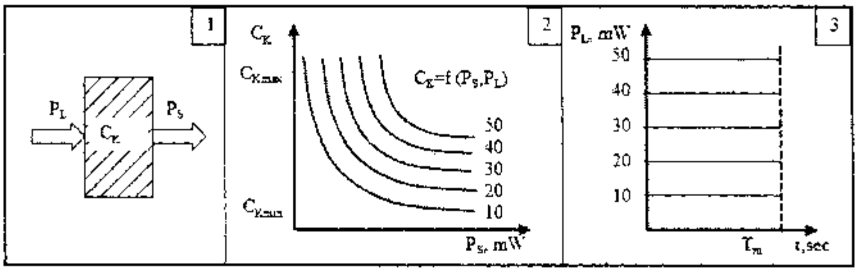

Fig. 1. Diagram of information-energy transformations of a laser signal during sounding the environment

On Fig. 1: $T(X,Y)C^0$ – thermodynamic field in the lane $(X \times Y)$, ULi – block of laser emitters of photon energy low, LCC – laser for concentration control, PD – photodetector, SPU – block of signal processing (computer data-analyzation system), $Rq(C_K)$ – the recorder.

Due to laser pulses and energy interactions, the chemical components of the dynamics equation have the form (7):

$$dX_i / dt = a_1 - b_1 X_i - C_1 X_i \exp(-E / RT);$$
$$dT / dt = a_2 - b_2 T + C_2 X_i \exp(-E / RT). \quad (7)$$

where T – is temperature, E – is the activation energy.

Procedure for the distribution of ions in fresh water [1] without processing which can be used as a solvent (8)

$$\left[HCO_3^- > SO_4^{-2} > Cl^-; Ca^{+2} > Mg^{+2} > Na^+\right] \quad (8)$$

Accordingly, an aqueous glutinous mixture will have in its composition both insoluble and soluble components that provide a process of gluing paper.

The infrared or red laser radiation absorbed by the molecule effectively excites high volatile levels to the level of dissociation and re-dissociation (isotonic selectivity) at the laser power (2-50) MW/sm and a pulse width of 100 ns.

Accordingly, this leads to a direct set of energy by the molecular structure at the expense of photons in the number of atoms in the structure.

In this case, respectively, pass the following processes in the molecular structure:

- isomerization and excitation of electronic states $\langle\langle \to OSO_4\rangle\rangle, \langle \to SiF_1\rangle$;
- ionization of molecules $\langle \to BCl_3^*\rangle, \langle \to SiF_4^+\rangle$;
- change of the rotating energy of the oscillatory state.

Such activation occurs in the compounds. which are included $\langle B, S, BCl_3.SF_6, H, Si, C, Cl, Mo\rangle$, as well as in triatomic molecules of the species $\langle OCS, O_3, NO_2\rangle$.

Multistage dissociation under the influence of a laser in strong infrared fields provides selectivity of excitation and, at the same time, possible tangles between molecules that provide an energy balance between laser excitation and the thermodynamic state.

The effect of oscillatory excitation of one of the reagents by a laser determines the speed of the chemical reaction of the drying process through a constant [5]

$$K = K_0 \exp\left[-\left(E_Q - \alpha E_K\right) / RT\right] \quad (9)$$

where $\alpha \in [0,3 \div 0,6]$ – for endothermic reactions, $E_K \in [2,5 \div 9,0]$ kcal / mole – is the photon energy in the visible range of laser beam generation.

In multiatomic molecules, when an excited state, there is a rapid energy exchange between oscillatory models, so oscillatory excitation will not be selective and distributed in all modes in time $\tau \in [10 \div 100] \times 10^{-9}$ sec.

The diagram has the form $P_L \to A(C_K, R) \to P_S \to U_S \to \varphi \to \hat{C}_K$, and the graded characteristic of the concentration function C_K relative to the model (see Figs 2, 1) is given on (see Figs 2, 2) in accordance with the change in laser power (see Figs 2, 3) (P_L).

Accordingly, the level of concentration and the rate of water and reagents evaporation is determined according to (10):

$$Z_S^{y_2}(t, C_K) = Z_C^{y_2}(t) A(C_K, \theta, X, y, Z);$$
$$P_S(y_2, t, C_K) = P_C(X,Y) \alpha(Y, C_K, K_r); \quad (10)$$
$$U_{PD}(Z_S, Y_S, C_K) = K_{PS} P_S(\varphi_S, C_K, l).$$

TABLE I. RESULTS OF THE EXPERIMENT FROM LASER-INFORMATION SYSTEM

№ of experiment	The values in the state change after 10 seconds									
	1 sec	*2 sec*	*3 sec*	*4 sec*	*5 sec*	*6 sec*	*7 sec*	*8 sec*	*9 sec*	*10 sec*
1	0,40	0,41	0,40	0,41	0,39	0,41	0,38	0,41	0,45	0,47
2	0,36	0,53	0,77	0,78	0,97	0,89	0,96	0,97	0,86	0,88
3	0,79	0,82	0,83	0,92	0,83	0,79	0,76	0,74	0,77	0,97
4	0,70	0,65	0,73	0,75	0,74	0,84	0,86	0,82	0,90	0,94
5	0,18	0,29	0,57	0,63	0,69	0,59	0,69	0,70	0,64	0,60

where $C_K = \varphi\left(U_{PD}\left(Z_S, Y_S, C_K, t\right)\right) \cdot R_{nd}$; $Z_C\left(Y_1\right)$ – sounding signal; $Z_S\left(Y_2\right)$ – the signal received by a photometer passed from the laser through optical windows OW1, OW2 and technological environment; P_C – laser power in the control system of the concentration and the component of the medium of the mixture; P_S – accepted laser signal of photoelectric receiver; P) – photoelectric receiver; U_{PD} – voltage of the photoelectric receiver; R_{nl} – coefficient of converting voltage-concentration according to function $\varphi()$, which connects the transformation in the measurement process.

In Table 1, we present the results of the experiment with the estimation of the solubility of chemical components by the method of laser resonance photometry based on the estimation of the change in the concentration of moist environment in the dynamics. These results are a synthesis of the integrated information system with laser monitoring.

IV. CONCLUSION

The possibility of constructing laser resonance photometers (based on combining of lasers and computer system) for evaluation of the rate of evaporation and concentration of chemical elements in glutinous compounds during drying of book blocks is considered in the article. Models of resonance interaction at laser control of chemical components solubility and pharmaceutical agents in an aqueous medium are analysed. It is shown that the method of laser resonance photometry with computer data-analyzation is an effective means of rapid analysis of impurities in an aqueous medium, and may be an important tool for data collection to form specific knowledge which are necessary in extreme situations to assess the degree of water pollution.

The proposed information technology of combining laser with computer data-analyzation system and created equipment are an effective tool for studying processes in liquids, oils, transformer oil and aqueous media. Can be used in energy, ecology, pharmacy and biochemical studies.

By the results of measurement $k_A\left(L,\theta\right)$ and $\tau\left(c_r\right)$ (and measurement-data analyzation) can determine the activity of the study environment, in which the following processes of interaction occur: $R(\Omega)$ – scattering by a solid angle Ω; $P(L)$ – absorption on the route L passing the laser beam; $k_A\left(L,\theta\right)$ – strengthening on the route L of laser signal; $F\left(R,\Pi,k_A\right)$ – composition of the interaction of the laser beam with the substance.

Accordingly, the measurement of these interactions is determined by the structure of the photometer, as an optical information and measurement system.

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