SCANNING TELEVISION OPTICAL MICROSCOPE FOR DIAGNOSTICS OF MICROOBJECTS IN MEDICINE

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Summary

Scanning television optical microscope (STOM) developed by authors will enable to diagnose microobjects which size exceeds 0,1 microns. Diagnostics can be carried out by supervision over researched microobjects during influence on them of various reagents and catalysts, and also definition of parameters of microobjects: the sizes, speed of movement, acceleration, growth rate, change of density, etc.

Ways of the scanning television microscope construction which can be used for the biological microobjects research are analyzed. The Microscope capabilities are expanded due to a raster formation in television and little-frame modes. Ways of the raster size change are offered at preservation of the microobject image resolution.

Key words: scanning microscope, electron beam tube, microobject, diagnostics

SKANUJĄCY TELEWIZYJNY OPTYCZNY MIKROSKOP DLA DIAGNOSTYKI MIKROOBIEKTÓW W MEDYCYNIE

Streszczenie

Skanujący telewizyjny optyczny mikroskop (STOM) skonstruowany przez autorów pozwoli na diagnozowanie mikroobiektów których rozmiar nie przekracza 0,1 mikrona. Diagnoza może być przeprowadzona poprzez obserwowanie badanych mikroobiektów podczas oddziaływania różnych reagentów i katalizatorów, oraz w celu określenia parametrów fizycznych mikroobiektów: wielkości, prędkości, przyspieszenia ruchu, tempa wzrostu, zmian gęstości itp.

Sposób skonstruowania skanującego telewizyjnego optycznego mikroskopu powala na badania i analizy mikroobiektów biologicznych. Możliwości mikroskopu zostały rozszerzone w stosunku do skanowania rastrowego i trybów mało-kadrowych. Zaproponowane zostały sposoby rastrowej zmiany rozmiaru ekranu przy zachowaniu rozdzielczości zdjęcia mikroobiektu.

Słowa kluczowe: skanujący mikroskop, lampa kineskopowa, mikroobiekt, diagnoza

INTRODUCTION

Scanning television optical microscope (STOM) developed by authors will enable to diagnose microobjects which size exceeds 0,1 microns [1-3]. Diagnostics can be carried out by supervision over researched microobjects during influence on them of various reagents and catalysts, and also definition of parameters of microobjects: the sizes, speed of movement, acceleration, growth rate, change of density, etc [4-7]. As a light source in such microscope electron beam tube (EBT) of the high resolution is used. Very short time of afterglow such EBT allows to use a mode of a running beam. Advantage of such microscope in comparison with a video television microscope consists in an opportunity of formation of the image of microobject (MO) which will consist of 5000 elements of decomposition on each coordinate. In comparison with electronic microscope STOM provides an opportunity to carry out researches in real time on alive MO. Advantage of the STOM in comparison with a laser microscope consists in much smaller energy of illumination that liquidates influence of a source of illumination on alive MO. Use of change of the sizes of a scanning raster will provide formation of image of MO with change of its scale without loss of the resolution of the image.

1. SCANNING MICROSCOPE STRUCTURAL SCHEME

The structural scheme of the STOM is submitted on fig. 1. Into its structure enter: the block of forming of scanning raster BFSR, block EBT of the high resolution BEBT, the block of management of operating modes scanning EBT BMOM, two block of the optical channel BOC1 and BOC2, researched microobject MO, the block of photoelectronic multiplier BPEM, the block of formation of video signal BFVS, the television monitor TM, the block of processing of video signal BPVS, personal computer PC with its monitor M.

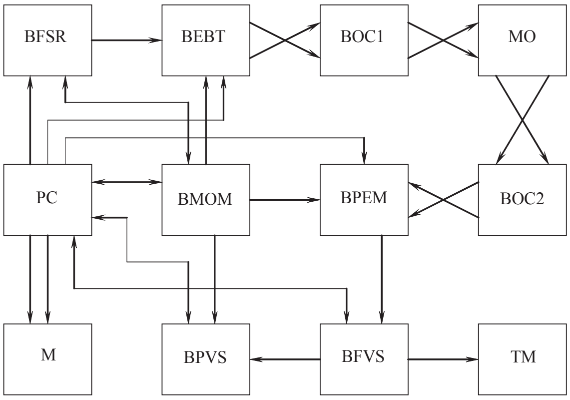

Figure 1. STOM provides formation of MO image on the screen of the television monitor which is used for the snap analysis of MO condition by the operator in real time. On results of the analysis by the operator it is made a decision on methods of the further research: increase in the image of all MO or its separate fragment, overlapping of a researched fragment with the center of EBT screen, discrete scanning with the increased resolution, increase of contrast of MO image, measurement of static and dynamic MO parameters, archiving of the image, etc. Results of processing of MO image are displayed on the monitor of a personal computer M

2. PRINCIPLE OF WORK

The principle of work of STOM will consist in the following. On screen of EBT the light scanning raster which with the help of optical channel block BOC1 is projected on researched microobject MO is formed. Light which has passed through MO, or was beat off from it moves on a photosensitive target of photoelectronic multiplier PEM. On an output of the block of the photoelectronic multiplier BPEM the signal which instant value is proportional to quantity of light which has arrived on a photosensitive target is formed. On an output of the block of formation of video signal BFVS the signal in the television standard which moves on television monitor TM and the block of processing of video signal BPVS is formed. BPVS makes an analog strip filtration of video signal and regulation of contrast. The block of management of operating modes BMOM chooses the following operating modes according to a command of the operator [1,7]:

- a television mode of formation of a scanning raster;
- a discrete mode of formation of a scanning raster with various resolution;
- a discrete mode of formation of a scanning raster with various frequency;
- a discrete mode of formation of a miniraster;
- a discrete and analog mode of formation of a scanning raster of the changeable sizes;
- a discrete and analog mode of moving of a scanning raster.

The personal computer is used for a choice of operating modes of STOM, processing of MO image by standard programs, archiving of the images, the automated definition of parameters MO - the sizes, the area, speed of movement, growth rate and others.

The internal structure of separate units of the STOM will be determined by a place of its possible use: a) research laboratories of the small medical organizations (the cheapest and simple STOM); b) research laboratories of the medical organizations (rather cheap with more wide opportunities); c) branch research laboratories for which the STOM should have the widest functionalities.

For the first case the most suitable is use of STOM with the minimal functionalities which works in a standard television mode. At use of PC cheap and standard systems of input and processing of images are applied to input of images researched MO in PC. Use in such microscope cheap EBT because in this case not necessarily to provide scaling the image researched MO due to change of the sizes of a scanning raster in wide borders is possible. Change of the sizes of a scanning raster and its displacement is expedient for making simple analog circuits.

In the second case use of an electron beam tube of the high resolution will be necessary. Formation of sweep which is equivalent to decomposition of the image 1000x1000 elements, it is possible to carry out as analog (with very small factor of nonlinearity of sweep), and digital way. Input of the image in a personal computer is necessary for carrying out with preliminary digitization of the image, therefore standard videoblasters for input of the image in a personal computer do not approach. Besides for processing images with the big digital files use of the difficult expensive specialized programs is necessary.

In the third case the STOM should have the greatest possible functionalities with the purpose of carrying out of the difficult specialized researches. Formation of sweep should provide decomposition of the image on 5000x5000 elements. For the snap analysis it is necessary to provide a television mode of formation of a scanning raster for input of the image in a personal computer, and for the detailed analysis digital sweeps which will provide high accuracy of formation of a scanning miniraster in any point of EBT screen with the purpose of detailed research of separate fragments of image MO can be used. In such microscope it is necessary to provide wide opportunities on change of factor of increase, sensitivity, regulation of contrast in wide borders, etc.

On fig. 2. the preparation of blood of the person on the monitor of a scanning electronic microscope (the top line) and blood unguent of the person on monitor of STOM (the bottom line) is represented.

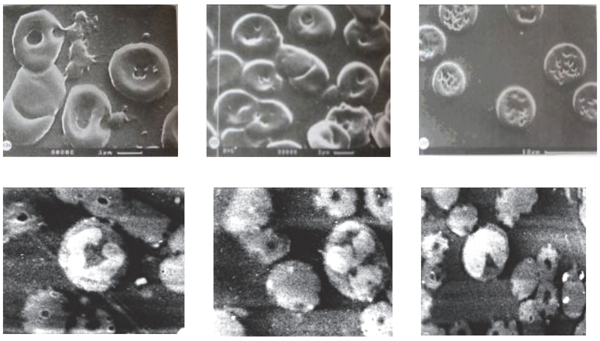

Figure 2. EBT together with electromagnetic electron-optical units of formation and management of electronic beam (focus-deflection complex) it is submitted on fig. 3. The basic condition of reception on EBT screen of a light spot of the minimal sizes is mutual adjustment axes of an electronic beam and an optical axis of a lens. Into the focus-deflection complex enter (from left to right): two electromagnetic systems of adjustment, the coil of focusing astigmatism correction and the coil of a coordinate deflection

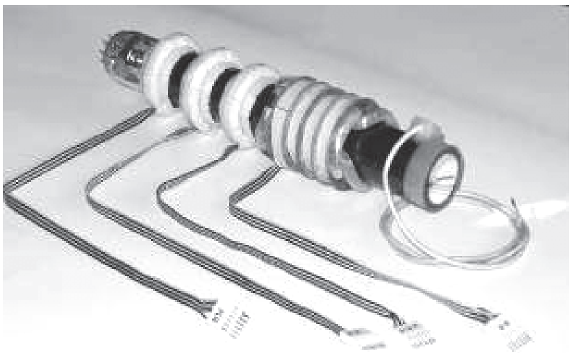

Figure 3. The device will consist of liquid crystal display (LCD), control panel (CP), microcontroller (MC), the block of measurements (BM) and the switchboard (S) and has the following characteristics

Use of STOM in comparison with other devices which use for research of biological and medical microobjects (MO), has such advantages:

- very small exposition of illumination that allows to investigate alive MO in real time;
- ultrahigh resolution of used EBT for scanning MO in comparison with used devices of display (the monitor of the personal computer, the television video-control device) allows to change scale of formed image of MO without loss of resolution;
- flexibility of formation of a scanning raster allows to choose operatively fragment of MO and to display its image in the increased scale on the television monitor;
- considerably the big depth of sharpness of the formed image in comparison with optical and video microscopes;
- an opportunity of MO illumination in a ultra-violet range with use specialized EBT and formation of MO image in a seen spectrum;
- absence of necessity of a putting researched MO in vacuum;
- simplicity of MO preparation to research;
- an opportunity of research of MO internal structure;
- an opportunity of research dynamic MO, etc.

Essential advantages of CTOM in comparison with video, optical and electronic microscopes enable to speak about their wide use in those branches where it is necessary to diagnose and define parameters of alive MO in real time without preliminary processing and harmful influence on MO, first of all, in medicine and biology.

The basic technical parameters of a laboratory breadboard model of a microscope [7]:

- the maximal factor of increase – 20000^x;
- factor of smooth change of scale – 1…10;
- the minimal size of a scanning element on researched object – 0,1 microns;
- a maximum of a spectrum of a luminescence of the screen of a tube – 0,54 microns;
- the minimal size of a light spot on the screen of a tube – 10 microns;
- a mode of scanning – TV the standard.
- power consumption – 150 W;
- overall dimensions - 240×350×700 (mm);
- weight – 22 kg.

3. SUMMARY

The developed scanning television optical microscope provides diagnostics of medical and biological microobjects which sizes exceed 0,1 microns in a wide spectral range of illumination in real time.

REFERENCES

[1] Prudyus I.: *Nanoluminescense a Scanning Optical Microscope for Research of Functioning of Microorganisms Under Influence of Low Temperatures* /I. Prudyus, A. Zaichenko, L. Palianycia, A. Pedan, V. Shkliarskyi// Modern Problem of Radio Engineering, Telecommunications and Computer Science TCSET’2012: XI intern. conf., February 21 – 24 2012 : Proceed. of the Conf. - Lviv-Slavske, Ukraine, 2012. – P. 38 – 39.

[2] Balanjuk Y.: *Scanning Television Optical Microscope for Research of Biological Microobjects* /Y. Balanjuk, B. Lubinecka, Y. Matiieshyn, A. Pedan, I. Prudyus, Gennadiy Turkinov, Volodymyr Shkliarskyi// Modern Problem of Radio Engineering,

Telecommunications and Computer Science TCSET'2010: X intern. conf., 23 – 27 February 2010: Proceed. of the Conf. - Lviv-Slavske, Ukraine, 2010. - p.18.

[3] Vasylyuk V.: *Raster Forming Block in ScanningTelevision Microscope* /V. Vasylyuk, V. Goy, V. Shkliarskyi// Modern Problem of Radio Engineering, Telecommunications and Computer Science TCSET'2010: X intern. conf., February 23 – 27 2010: Proceed. of the Conf. - Lviv-Slavske-Ukraine, 2010. - p. 67.

[4] Balanjuk Y.: *Scanning Television Optical Microscope With Illumination of Microobject in a Ultra-Violet Range* / Y Balanjuk, Y. Matiieshyn, A. Pedan, V. Shkliarskyi. // Modern Problem of Radio Engineering, Telecommunications and Computer Science TCSET'2012: XI intern. conf., February 21 – 24 2012 : proceed. of the conf. - Lviv-Slavske, Ukraine, 2012. - P 113.

[5] Matiieshyn Y.: *Research of Dynamic Microobjects of the Various Sizes and Forms With the Help of a Scanning Television Optical Microscope* //Y Matiieshyn, V Shkliarskyi, V Storozh// Modern Problem of Radio Engineering, Telecommunications and Computer Science TCSET'2012: XI intern. conf., February 21 – 24 2012 : proceed. of the conf. - Lviv-Slavske, Ukraine, 2012. - P 114.

[6] Hudz B.: *Video Signal Forming Block in ScanningTelevision Microscope* / B. Hudz, Y. Matiieshyn, V. Shkliarskyi. // Modern Problem of Radio Engineering, Telecommunications and Computer Science TCST'2010: X intern. conf. February 23 – 27 2010: Proceed. of the Conf. - Lviv-Slavske, Ukraine, 2010. - p. 111.

[7] Shkliarskyi V.I.: *Scanning Television Optical Microscopy: theory and practice: monography* / V.I. Shkliarskyi. – Lviv Polytechnic Press.– 2010.– 456 p.

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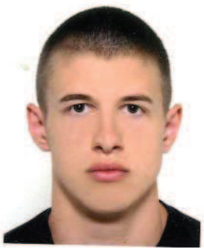

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