ДПС-2018

Міжнародна наукова конференція «Датчики, прилади та системи»

ТЕЗИ ДОПОВІДЕЙ

VII Міжнародної науково-технічної конференції

ДАТЧИКИ, ПРИЛАДИ ТА СИСТЕМИ - 2018

присвяченої пам'яті професора Шарапова В.М.

book.druk
видавництво • друкарня • сувеніри
тел. 067.444.28.94

17 - 21 вересня 2018 року
Черкаси • Херсон • Лазурне

Секція 8

ЕКОНОМІКА, МЕНЕДЖМЕНТ ТА МАРКЕТИНГ У ПРИЛАДОБУДУВАННІ

UDC 658

Bondarenko M., PhD, Assoc. Prof.,
Assoc. Prof. of the department of instrumentation, mechatronics and computer technologies
Medyanyk V.,
Post-grad. Stud. of the department of instrumentation, mechatronics and computer technologies
Bilokin S., PhD,
Senior Lecturer of the Department of Physics
Cherkasy State Technological University
e-mail: maxxium23@gmail.com, tel. +38 (0472) 730260

INDICATORS FOR EVALUATION OF ECONOMIC EFFICIENCY OF METROLOGICAL EQUIPMENT OF THE ATOMIC-FORCE MICROSCOPY IN THE STAGE OF DESIGN

Abstract*. The paper presents an approach for estimating and calculating the economic efficiency of metrological equipment of atomic-force microscopy, which is created to control devices of micro- and nanoelectronics at the stage of their design. It is estimated that the creation of a modern metrological laboratory using the atomic force microscopy method in the conditions of the modern Ukrainian economy will make it possible to reach profit only after 32-38 months by reduction the time of control with a simultaneous decrease in the proportion of products which are not satisfying the requirements of modern micro and nanoelectronic devices.*

Keywords*: economic indicators, metrology, atomic-force microscopy*

Анотація*. В роботі наведено підхід для оцінки і розрахунку економічної ефективності метрологічного обладнання атомно-силової мікроскопії, яке створюється для контролю пристроїв мікро- та наноелектроніки на стадії їх проектування. Підраховано, що створення сучасної метрологічної лабораторії із застосуванням методу атомно-силової мікроскопії в умовах сучасної української економіки дозволить вийти на прибуток лише через 32-38 місяців за рахунок зменшення часу контрою з одночасним зменшенням частки виробів, що не задовольняють вимогам сучасного виробництва пристроїв мікро- та наноелектроніки.*

Ключові слова*: економічні показники, метрологія, атомно-силова мікроскопія*

The current level of requirements for the control of products of microelectromechanical systems and optoelectronics of nanometric dimensions causes an intensive transition to the search for new methods for implementing approaches and methods of control. To such methods, first of all, methods based on the principles of probe microscopy, namely, methods of atomic force microscopy (AFM) [1, 2].

A prerequisite for the implementation of such a control method is the creation of special metrology equipment for AFM, which has its own design features in comparison with existing equipment [3].

The purpose of this task is to determine the criteria, when designing metrological equipment for AFM, for the economic effectiveness of such a control method when it is used in the production of micro- and nanoelectronic devices (microelectromechanical systems, optoelectronic devices, micro- transducers, etc.).

As a criterion, an indicator is proposed that corresponds to the ratio of the reduced costs to the annual output that successfully passed the control phase by the AFM method, and which can be calculated using expression:

$$e = C / (P \cdot n), \quad (1)$$

where C – annual costs for the implementation of metrological equipment of AFM, UAH; P – annual productivity of control by AFM method, pcs.; n – number of products that have successfully passed control by the AFM method, pcs.

Evaluation of the effectiveness of activities related to the manufacture and implementation of AFM equipment is primarily related to social, economic, environmental and other factors in the state. At the same time, the economic effect by the conditions for the creation and use of the AFM method should reflect as much as possible all stages of the cycle "science - production - use".

The economic effect (e_y) by years of such an calculated period can be determined using expression:

$$e_y = R - C, \quad (2)$$

where R – price estimate of the results of activities to create and implement the AFM method for the calculated period; C – price estimate of costs for activities for the creation and implementation of AFM equipment for the calculated period.

When calculating the economic effect, the calendar year should also be taken into account which precedes the beginning of the release or use of equipment to control products.

Thus, must be considered different time (by years) expenses for the implementation of activity for create and implement metrological equipment to the calculating year. For this it is necessary to use the coefficient of adduction to the calculated year α_y, which can be found from expression:

$$\alpha_y = (1 + E_n)^{t_y - t}, \quad (3)$$

where E_n – the standard of adduction in different costs, numerically equal to the norm of the efficiency of capital investments; t_p – calculating year; t – year, the costs of which are shown to the calculation year.

As the initial year of the calculated period, the year of commencement of financing of works is adopted for the creation of metrological equipment. The final year of the calculated period is determined by the end of the period of use of the equipment (taking into account the obsolescence).

A price evaluate of the results of using the AFM method can be performed using expression:

$$P_t = C_t \cdot N_t \cdot P_t, \quad (4)$$

where C_t – an increase in the price of a unit of production, when it passes AFM control during a summer period t; N_t – volume of use of the AFM method over a summer period t; P_t – the productivity of the AFM method over a summer period t.

The estimate of costs for the use of metrological equipment is calculated using the formula:

$$R_t = R_t' + K_t - V_t, \quad (5)$$

where R_t – expenses for all types of resources for the creation and implementation of AFM equipment, as well as its operation over a summer period t; R_t' – current costs of using equipment for the summer period t (without depreciation charges for renovation); K_t – one-off

costs when using the AFM method for a summer period t; V_t – the residual value of fixed assets that fall outside the summer period t as a result of the introduction of the AFM method.

Thus, using the criteria (3-5), it is possible to calculate (2) the overall economic effect on the creation and use of AFM equipment.

As an example, we will cite some of costs for the creation of a modern laboratory for monitoring elements of micro- and nanoelectronics (microelectromechanical systems of the navigation gyroscope), Fig. 1.

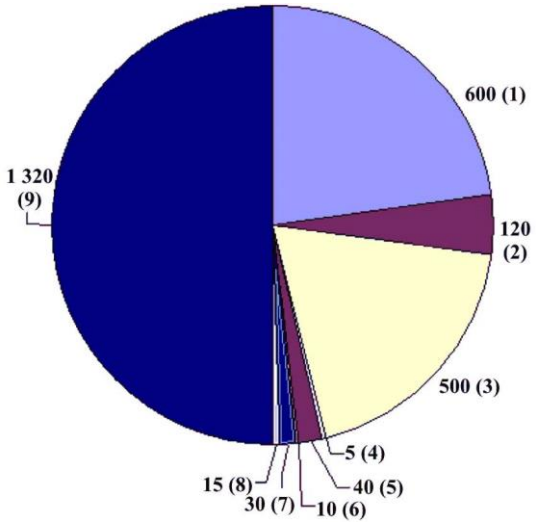

Fig. 1. Expenditures on the modern laboratory of control of elements of micro and nanoelectronics by the AFM method (ths. Euro): 1 – equipment; 2 – salary; 3 – materials; 4 – electricity and other energy sources; 5 – conducting scientific researches; 6 – tools; 7 – services of other organizations and firms; 8 – rent of premises and office equipment; 9 – Other expenses.

Conclusions. The presented approach is recommended for the estimation and calculation of the economic efficiency of the AFM metrological equipment, which is created for monitoring devices of micro- and nanoelectronics (microelectromechanical systems, optoelectronic devices, micro-perverting etc.) at the stage of their design. It is estimated that the creation of a modern metrology laboratory using the AFM method in the conditions of the Ukrainian economy will allow to reach profit in about 32-38 months by the reduction the time of control with a simultaneous decrease in the proportion of products which are not satisfying the requirements of modern micro and nanoelectronic devices.

Literature

1. Metody ta zasoby mikroskopii (*Methods and means of microscopy*): monohrafiia / V.S.Antoniuk, H.S.Tymchyk, Yu.Iu.Bondarenko, P.V.Petlovanyi, S.O.Bilokin, M.O.Bondarenko // K.: NTUU «KPI», 2013. – 336 s.
2. Mikroskopiia v nanotekhnolohiiakh (*Microscopy in nanotechnology*): monohrafiia / V.S.Antoniuk, H.S.Tymchyk, O.V.Vertsanova, Yu.Iu.Bondarenko, S.O.Bilokin, M.O.Bondarenko // K.: NTUU «KPI», 2014. – 258 s.
3. *Bondarenko M.O.* Avtomatizovanij kompleks dlya nanometrichnih doslidzhen' (*Automated complex for nanometric research*) / M.O.Bondarenko, YU.YU.Bondarenko // Fizika, elektronika, elektrotekhnika (FEE-2016): nauk.-tekhn. konf., 18-22 kvitnya 2016 r: tezi dop. – Sumi: SumDU, 2016. – S. 200.