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IMPROVED EXPERIMENTAL DEVICE FOR STUDYING DEFECT FORMATION IN STRUCTURAL MATERIALS

I. P. Miroshnichenko and A. G. Serkin

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Results are presented for the development and introduction of a modified experimental device for studying defect formation in specimens of prospective structural materials prepared on the basis of test operating analog devices.

Key words: *experimental device, bending tests, structural material specimens.*

Scientific and procedural facilities for defectoscopy are currently quite well developed, but in choosing a study method it is necessary to consider features of a specific problem. For example, acoustic emission (AE) methods, used for studying material breakdown, make it possible to determine reliably the yield strength, instant of micro- and macrocrack initiation and development, and some other material properties. However, exposure and localization of failure sources in structural elements of complex configuration by the AE method is difficult. Therefore, a promising area and means of non-destructive monitoring is development of unified experimental-measurement devices combining the achievements of several defectoscopy methods.

Results have been presented in [1] for development of an experimental device for studying defect formation in strip high-temperature superconductors (HTSC), that were employed for evaluating the defectiveness of specimens in bending tests. The basis of this technical solution is an AE method for studying defect formation, and in order to increase accuracy and establish a clear relationship between specimen loading parameters and AE signals, strain gauge and interference measuring devices are used, and also new optical technology is implemented [2]. In the construction of a meter there are several technical solutions, protected by patents for inventions [3, 4], that make it possible to separate it among standard laser interferometers.

In spite of the unique nature of this technical solution, during its operation structural imperfections were revealed, leading to additional errors due to external acoustic noise. Joining of heavy-duty elements in a rigid closed construction leads to development of marked random disturbances (during device operation in order to create a load interaction and deformation of heavy-duty elements during testing, etc.), which considerably affects the accuracy of test results and excludes a study of defect formation in thin specimens. Cantilever fastening of individual elements of the loading and recording system gives rise to additional errors due to elastic strains in the measuring chain, whose completing link was a test specimens, etc. In view of this, an important task is structural improvement of the experimental device [1].

A feature of the experimental device [5] consists of a functional combination of a device for creating a load with measurement facilities (Fig. 1). In the base *1* of the device for testing specimens in plane *2* there is a bush *3* made of damping material and a device *4* for load creation. Rod *5* provides movement of the movable plate *6* with supports *7* installed upon it. Longitudinal and transverse movement of test specimen *8* freely positioned on supports *7* is limited by a Π-shaped guards *9*. Immovable plate *10*, installed on an additional base *11* by means of pillars *12*, has a central hole *13* and a central support *14* with a cavity *15* for placing a piezo-transducer *16* of the acoustic emission recording system during specimens *8* testing (not shown in Fig. 1). The strain gauge force meter *17* is made in the form of a hollow cylinder *18* with flanges, i.e., upper *19* and

Nedelin Rostov Military Institute of Rocket Forces, Rostov-on-Don, Russia; e-mail ipmir@rambler.ru. Translated from Metallurg, No. 3, pp. 68–69, March, 2010. Original article submitted October 14, 2009.

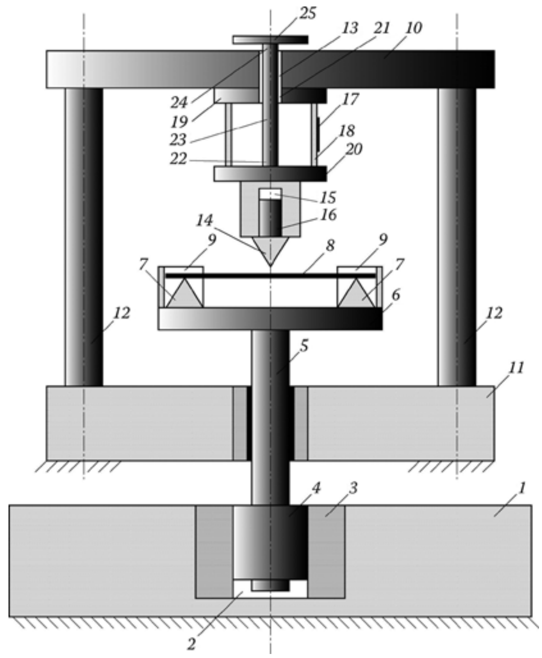

Fig. 1. Layout of improved device for specimen testing.

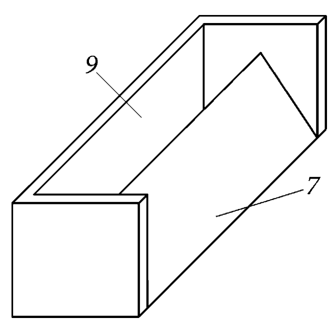

Fig. 2. Layout of support on a mobile plate with a Π-shaped guard for specimen longitudinal and transverse movement.

lower *20*. The upper flange *19* is fastened with the immobile plate *10* and it has a central hole *21*, coaxial with hole *13* in the immovable plate *10*. The lower flange *20* from the outer side is connected with a central support *14*, and at the inner side it is rigidly fastened at one end *22* of a cylindrical rod *23*, passing through the central holes *21* and *13* correspondingly of the upper flange *19* and immovable plate *10*. At the other end *24* of rod *23*, a reflector *25* is installed for providing contact-free connection with the optimum movement meter (not shown in Fig. 1), for example with a triangulation displacement meter, interference displacement, etc.

The experimental device operates as follows. Before the start of a test, a specimen *8* is freely placed on supports *7* between Π-shaped guards *9*, excluding is transverse and longitudinal movement (Fig. 2).

On command, the control system for tests creates a load *4* provided by means of rod *5* to the mobile plate *6* with supports *7* installed upon it, guards *9* and test specimen *8* over the direction towards the central support *14*.

Loading of a test specimen *8* is carried out from the instant of contact of its surface with the central support *14* and continues until achieving the prescribed bending over the contact area with central support *14*, etc.

During loading with specimen *8*, deformation acoustic emission signals are recorded by means of a piezo-element *16*, specifying defect formation in a specimen *8*, axial force by means of a strain gauge meter *17* and axial movement of the lower flange *20* of meter *17* by means of components *23* connected with it, reflector *24* and a contact-free optical displacement meter (no shown in Fig. 1).

In some cases, for example, with minimum deviations of physicomechanical properties of specimens, it is possible for the results of measurements from a contact-free optical displacement meter to monitor loading parameters.

A technical result of improving the experimental device [1] is expansion of the functional potential due to studying defect formation in thin specimens of promising structural materials in bending tests.

Preliminary tests have been performed using the proposed experimental device, that confirm the validity of the technical solutions imposed upon its construction and achievement of a notable technical result.

The improved experimental device, retaining the positive qualities of the device in [1] and existing analogs, is distinguished by expansion of the functional possibilities due to performing studies of defect formation in specimens of potential structural materials during bending tests, and it may be used, for example, in studying defect formation in thin specimens of strip high-temperature superconductors and instrument-, machine-, ship-, and aircraft-construction., and in other branches.

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REFERENCES

1. A. G. Serkin, I. P. Miroshnichenko, I. A. Parinov, and E. V. Rozhkov, “Experimental device for studying defect formation is strip high-temperature superconductors,” *Metallurg*, No. 7, 77–78 (2006).
2. I. P. Miroshnichenko, A. G. Serkin, and V. P. Sizov, “Introduction of interference measurement technology into studying potential materials and objects,” *Proc. 12th Int. Conf. Contemporary Problems of Solid Mechanics*, Rostov-on-Don, December 1–4, 2008.
3. V. E. Alekhin, I. P. Miroshnichemko, A. G. Serkin, and V. P. Sizov, RF Patent 2343402, MPK. G01B9/00, “Optical device for measuring object surface displacement,” Publ. 01.10.2009, *Byull.*, No 1.
4. V. E. Alekhin, I. P. Miroshnichemko, A. G. Serkin, and V. P. Sizov, RF Patent 2343403, MPK. G01B9/00, “Method for recording displacements by optical transducer,” Publ. 01.10.2009, *Byull.*, No. 1.
5. I. P. Miroshnichenko, I. A. Parinov, E. V. Rozhkov, and A. G. Serkin, RF Patent 2376567, MPK G01N3/00, “Device for testing thin specimens in bending,” Publ. 12.20.2009, *Byull.*, No. 35.