

Preface

A great amount of the industrial equipment in Ukraine long ago exhausted the lifespan for which it was designed. Its replacement today is either economically unprofitable or, for various other reasons, impossible. This causes us to use such objects of durable operation in close-to-critical conditions. To extend the safe operating life of the equipment, it is necessary to use new, modern methods and facilities of strength and durability diagnostics. Besides, in some fields of production, new materials and technologies are introduced, experience of their operation under conditions of intensive loading and the aggressive effect on the environment is insufficient and therefore these objects need to be monitored.

An analysis of the causes of failure of structural materials, which are widely applied in engineering, the power-generating industry, pipeline transport, aircraft construction, chemical and oil industry, etc., has showed that in most cases failure occurs due to the initiation and propagation of crack-like defects. Therefore, investigation of these processes becomes an extraordinarily important task. It is also conditioned by the fact that on the one hand, it is necessary to study the mechanisms of defect initiation, and propagation, and to develop on this basis the effective methods of improvement of the durability, reliability, and other service characteristics of materials—and on the other to investigate the phenomena that accompany deformation and fracture of materials and eventually provide bases of new physical methods of non-destructive testing.

The initiation and development of defects cause a number of accompanying physical phenomena. The most interesting are those related to the transfer of energy or matter; they are what allows us to effectively detect the defects and determine their parameters at certain (sometimes considerably large) distances from their locations. The radiation of heat, electrons, electromagnetic and elastic waves are among them.

A phenomenon of elastic wave radiation during the deformation or fracture of materials, phase transformations and precipitation of second-phase particles, magnetic or surface transformations in materials is called “acoustic emission.” Experience over the last few decades testifies to the great potential possibilities for the acoustic emission method. It is especially appropriate in situations where it is

impossible to visually check the cracks' initiation and propagation because of their tunneling in material, or when there is no access to the inspected object. The remoteness of the examination, high sensitivity, and possibility to detect the distant defects, which exceed their sizes by many orders of magnitude—independent of the shapes and sizes of the inspected object—the realtime recording of fracture development and so on, are the advantages that place the acoustic emission method in the lead among all the known prospective methods of non-destructive testing.

The successful application of the acoustic emission method for the observation of the state of materials and products is possible only if scientifically grounded methods and proper facilities for their realization are available. Today, despite a great number of publications and undoubted progress in the development of equipment, there are certain difficulties in correctly selecting and applying the methodological bases of this method.

In this monograph, the physical aspects of the problem are analyzed in detail; the methodological bases of the practical use of acoustic emission devices, known both in Ukraine and outside it, are described; the results of theoretical and experimental research of peculiarities of evaluation of the crack growth resistance of materials are discussed; and the selection of the useful AE signals, etc., are presented. The methods' efficiency is shown in the conditions of diagnostics of multi-purpose industrial objects. The results of experimental research have been obtained by the authors with the help of the new methods and facilities, and some of them are thanks to the support of the Science and Technology Center in Ukraine (grants Nos. 1689, 1628 and 3905).

The authors have made an attempt to synthesize and classify not only their own, but also other information culled from the literature, in order to create clear approaches to the practical use of acoustic emission. They hope that the results presented in this monograph will be of great interest to the specialists who deal with the problem of non-destructive testing and the technical diagnostics of products and structures operating in various fields of human activity.

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