1.7.15. DIAGNOSTICS OF DEFORMATION AND FRACTURE STAGES ON THE BASIS OF ACOUSTIC EMISSION, OPTICAL MICROSCOPY STRAIN GAUGING

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From the point of view of carrying out of experimental researches of deformation behaviour of structural materials the method of acoustic emission (AE) is very informative as allows to obtain the information from entire gauge length of a loaded specimen during generation of deformation defects of a microscale level (first of all, dislocations and their ensembles, twins, etc.). At the analysis of plastic deformation and fracture processes the account of deformation processes and their carriers at larger, in comparison with microscale, levels can be realized by use in situ registration methods (for example, television-optical methods or Digital Image Correlation, speckle interferometry, photoelastic coatings method, ultrasonic diagnostics, etc.) is a great of importance, as well. The importance of multilevel consideration of deformation and fracture processes is caused by variety of deformation processes, their interaction and changing of crucial role at various stages of loading. From the position of experimental research the multilevel consideration can be reached only with use of a various kind and an operating principle of sensors.

An important point during experimental estimation of deformations based on construction of displacement vector fields is continuous “in situ” monitoring over area of strain localization. This can be provided due to localization of deformation processes in the specimen cross-section by making a notch. In the present work the joint research results on features of deformation development of structural materials carried out by means of digital image correlation (DIC), hardware-software complex for registration of acoustic emission (AE – a microscale level) and strain gauging are presented.

We investigated peculiarities of deformation development at the micro- meso- and macro levels of flat specimens of different structural materials and alloys as well as ones with a notch. Also, specimens of stainless steel with a surface strengthened by ion nitriding method with various time of thermo-chemical treatment have been analyzed. It was supposed that due to cracking of the strengthened layer the cracks acting of as structural notches of various depths will change the character of deformation localization.

It is shown that deformation localization caused by a notch in a different degree affect the pattern of acoustic emission under deformation of various materials. In more ductile materials (AMG6AM, steel 20) increase in acoustic activity is observed when the specimens have notches. The last, most likely, is related to intensive strain hardening of materials under investigation in the vicinity of the notch. Deformation of notched specimens of materials of less ductility (steel 45, titanium alloys OT4, VT20) is accompanied by reduction of the registered number of AE events at conservation of signals energy during the test. The given result, most likely, is associated with the small area of deformation localization zone and the general reduction of number of moving and formed defects of acoustic emission potential sources.

Carried out researches have revealed the pronounced interrelation between character of AE signals change and intensity of strain development being fixed by results of the television- optical measurements and strain gauging. The results obtained are evident acknowledgement of well-manifested interrelation of plastic deformation processes at various scale levels. The calculated numerical values of analyzed parameters have allowed finding the conformity between intensity of AE signals and a degree of deformation localization of deformed specimens, first of all, in terms of stage patterns for the analyzed processes.