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Verification and control of composite machining speed with usage of acoustic emission

The outcomes researches of acoustic radiation statistical energy parameters mutual change at operating the different factors are reviewed. It is shown that the ascending of cutting depth does not influence on value coefficient characterizing the ratio of acoustic emission signal energy average level to acoustic emission signal energy average level standard deviation. It is shown that the regularity of investigated dimensionless coefficient change at ascending machining speed has not linear nature decreasing. The obtained investigated coefficient regularity change can be used for adaptive control of composite machining speed. Thus during CM machining it is necessary to conduct record the AE signal, perform calculations and follow change the ratio of AE signal energy average level to AE signal energy average level standard deviation on a chosen analysis interval.

Assignment formulation. At composite materials (CM) machining the researches with usage conventional and not conventional methods are carried out. The researches are directed on optimization, control and monitoring the technological processes for obtaining items given quality. One of not conventional researches methods is the method of acoustic emission (AE). The AE method is reflection dynamics processes in contact zone of interplay treated and treating materials. It allows receiving information on processes on submicro, micro and macro levels of deforming and destruction materials surface layers. Thus the received regularity of AE parameters changes are the basis in the development methods for verification and control technological processes.

The results of AE theoretical and experimental researches at CM machining [1 - 4] demonstrate that the technological parameters, physical-mechanical characteristics treated and treating materials, and also tool wear influence on statistical AE signals amplitude-energy parameters. Technological parameters are: machining speed; cutting depth; feed rate. As demonstrate researches, the change of influential factors values results in increasing or decreasing of AE signals statistical amplitude-energy parameters values. So in article [1] is shown, that at ascending machining speed there is not a linear ascending of AE signals mean and root mean square (RMS) amplitude value. Composite nature have the relations of AE statistical amplitude parameters change at ascending the treating tool feed rate and machining depth. At simulation of AE signals in article [2] is determined, that at increase of composite of machining speed the relations of AE signals energy average level, its standard deviation and the dispersions change have not linear nature of ascending. At increase of composite machining depth the linear ascending of AE signals energy average level and its standard deviation is watched [3]. At the same time, the AE signals energy average level dispersion increases not linearly. According to the data of article [4], decreasing the treated CM disperse properties results in linear ascending of AE signals energy average level. Thus the AE signals energy average level standard deviation and its dispersion increase not linearly. The outcomes of conducted researches demonstrate that influencing the different factors on AE statistical amplitude-energy parameter is resulted in a problem to mining the methods verification, monitoring and control of CM machining technological processes.

For solution of the indicated problem the value has looking up of parameters, which one mirror influencing the different factors on AE statistical amplitude-energy parameter mutual change. As demonstrate researches, at operating the different factors large sensitivity have the AE statistical energy parameters. For looking up of parameters, which are possible for using at control of CM machining technological processes, the concern introduces the analysis of AE statistical energy parameters legitimacies mutual change.

Research tasks. To conduct processing of model AE signals at ascending of CM machining speed and cutting depths with definition of AE signals statistical energy parameters legitimacies mutual change. To conduct the description of legitimacies coefficient change describing the ratio of AE signal energy average level to its standard deviation for a given value of the influencing factor.

Researches results.

For realization the analysis of AE signals statistical energy parameters mutual change at ascending CM machining speed and cutting depths we shall use outcomes of simulation, which one are obtained in article [2, 3]. Let's conduct calculations coefficient K_E, which one represents ratio of AE signal energy average level to AE signal energy average level standard deviation at a set value of the influential factor

$$K_E = \frac{\overline{E}}{s_{\overline{E}}}, \qquad (1)$$

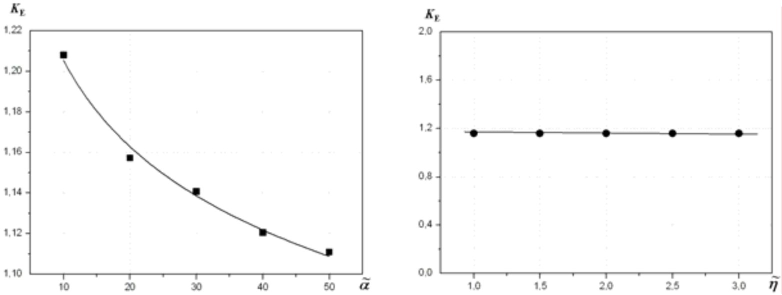
where $\overline{E}$ - AE signal energy average level; $s_{\overline{E}}$ - AE signal energy average level standard deviation.

The dimensionless coefficient K_E agrees (1), characterizes a ratio of AE signal energy average level and signal energy average level standard deviation mutual change at ascending the value of influential factor.

Outcomes of theoretical calculation coefficient K_E relations change at ascending CM machining speed ($\tilde{\alpha}$) and ascending CM machining depths ($\tilde{\eta}$) under the data simulation of acoustic radiation energy, that obtained in article [2, 3], are shown in Fig. 1.

The outcomes of researches demonstrate that at ascending CM machining speed there is a mutual change of AE signals energy parameters.

Thus, as demonstrate the conducted calculations, at ascending CM machine speed the increase of AE signal energy average level standard deviation advances increase of AE signal energy average level. Such mutual change of AE signals statistical energy parameters results in decreasing value of coefficient K_E (Fig. 1, *a*).



a *b*

Fig. 1. Relations of coefficient K_E change by the results of theoretical calculations:

a - at ascending CM machining speed ($\tilde{\alpha}$);

b - at ascending CM machining depths ($\tilde{\eta}$)

The relation of coefficient K_E change is not linear and is well described by expression of kind

$$K_E = \tilde{\alpha}^b, \quad (2)$$

where $\tilde{\alpha}$ - CM machining speed; *a* and *b* - coefficients of approximating expression.

The approximating expression (1) coefficients *a* and *b* values are peer: *a*=1.35824; *b*=-0.05186. At the description of relation on Fig. 1, *a* expression (1) determination coefficient R^2 is peer - R^2 =0.99191

At the same time, as demonstrate theoretical investigations outcomes, at constant values of machining speed and CM treated physical-mechanical characteristics with ascending machining cutting depth the ratio of AE signal energy average level to AE signal energy average level standard deviation practically remains by a constant (Fig. 1, *b*). As it is visible from Fig. 1, *b*, the relation of investigated coefficient K_E change practically is parallel to the axes X. It means that the ascending of CM machining cutting depth (volume) with other things being equal has identical interaction interference on increase of AE signal energy average level and AE signal energy average level standard deviation. In other words at ascending CM machining depth there is a proportional increase of AE signal energy average level and AE signal energy average level standard deviation.

The outcomes of researches demonstrate that the regularity of coefficient K_E change, i.e. constancy or the change of mutual ratio AE signal energy average level to AE signal energy average level standard deviation at operating the different factors can be utilized as parameter for control of CM machining technological processes. Such technological parameter is the CM machining speed, the value is connected which one about a diameter of a work piece. For the verification and adaptive control by CM machining speed it is necessary to perform calculations and monitor the change of coefficient value, which describing the ratio of AE signal energy average level to AE signal energy average level standard deviation at a given analysis interval.

Conclusions

The data processing of acoustic radiation energy simulation at ascending of CM machining speed and machining cutting depths is conducted. The calculations of dimensionless coefficient which describing ratio of AE signal energy average level to AE signal energy average level standard deviation at ascending CM speed and machining cutting depth are conducted. It is shown, that at ascending CM machining speed the dimensionless coefficient relation change has not linear nature of decreasing. It is conditioned by that at ascending CM machining speed the increment of AE signal energy average level standard deviation advances increment of AE signal energy average level. It is shown, that at ascending CM machining depth does not influence on investigated dimensionless coefficient value. The regularity of investigated coefficient change at ascending CM machining speed at constancy of other influential factors can be utilized for adaptive control of CM machining speed. Thus during CM machining it is necessary to conduct record the AE signal, perform calculations and follow change the ratio of AE signal energy average level to AE signal energy average level standard deviation on a chosen analysis interval.

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