ON THE EVALUATION OF SOLID DIELECTRIC STRENGTH UNDER COMBINED ELECTRICAL AND MECHANICAL PULSE ACTION

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It is well known that decreasing the duration of pulse action on solid insulation leads to an increase in the amplitude of destructive action of both electrical and mechanical nature

The following relationship is used to compare the parameters of such effects and to evaluate their combined effect on the system state:

$$\frac{\max\limits_{(x,y,z)} \int_0^t w_p(t,x,y,z)\big|_{PA}\,\mathrm{d}t}{\tau_L\big|_{PA}} \le w_{p0}\big|_{PA}, \qquad (1)$$

where w_p is potential energy density corresponding to destruction under mechanical impact ($PA \to fr$) or electrical breakdown ($PA \to el.\ br$). The material parameter $\tau_L\big|_{PA}$ – energy accumulation time is determined at controlled loading history and fracture energy density $w_{p0}\big|_{PA}$ under static conditions. The breach of condition (1) corresponds to the transition to the destroyed state. Moreover, the relative power

$$\Lambda\big|_{PA} = \left(w_p/w_0\right)\Big/\left(T_p/\tau_L\right)\Big|_{PA},$$

required for fracture, is independent of the type of energy impact

$$\Lambda\big|_{\forall} = \mathrm{const}\left(\left(T_p/\tau_L\right)\Big|_{\forall}\right)^{-2},$$

T_p is characteristic time of threshold destructive action. Considering the additive nature of energy, the change of state of the system under the combined action is determined by the total impact of energy flows in the corresponding points of space:

$$\Lambda\big|_{\Sigma} = \max_{(x,y,z)} \sum_{PA} \left(\Lambda\big|_{PA}\right).$$

The dependences presented in Fig. 1 demonstrate the sensitivity of electrical strength to concurrent mechanical impact for different material parameters and loading modes. Determination of accumulation times requires control of loading parameters, which is simplified when using the magnetic-pulse method of forming controlled impacts [1] and is performed according to the methods described in [2, 3].

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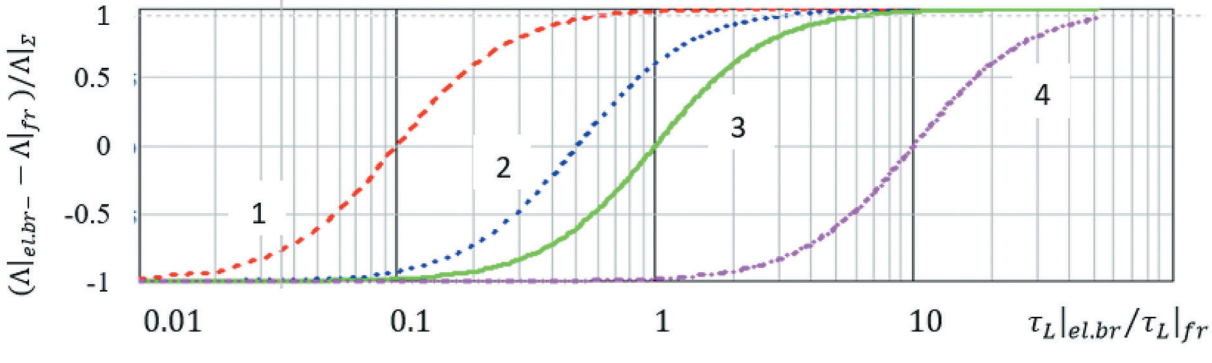

Fig. 1. Electric energy contribution to fracture under combined pulse action for different loading durations $T_P\big|_{el.br}\Big/T_p\big|_{fr}$:
1 – 0.1; *2* – 0.5; *3* – 1; *4* – 3

References

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