STUDY OF CRACK BEHAVIOUR DURING MECHANICAL STRESSING OF COMPOSITE MATERIALS

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The phenomenon of stochastic electromagnetic emission (EME) from solids is based on the generation of an electromagnetic field accompanying the mechanical excitation of the solids in question. This phenomenon may be triggered, for example, by external pressure, tensile force, bending, shearing, shocks, etc. Simultaneously with an EME signal an acoustic signal (AE) is generated (Fig. 1).

Our diagnostics method design is based on an experimental fact, namely, that the formation of a crack in an electrically non-conducting material is accompanied by the generation of electric charges $+q(t)$ and $-q(t)$ on the crack opposite faces. As a rule, the magnitude of these charges grows up in the course of the crack formation. In consequence of the material finite resistance, the charge magnitude starts decreasing after the crack unclenches. The charge movement velocity, $v(t) = \mathrm{d}l/\mathrm{d}t$, where l is the distance between crack faces, is related to the crack face movement velocity and depends on the time, too.

The time development of a voltage $u(t)$ across a load resistor being connected in series with a sensing capacitor was measured. For this voltage, a differential equation holds

$$\frac{\mathrm{d}u}{\mathrm{d}t} + \frac{u}{RC} = \frac{E_1}{C}\, q(t)\, v(t)\,, \tag{1}$$

by means of which the time behaviour of $q(t)\cdot v(t)$ can be determined from the voltages $u(t)$ measured. It holds

$$q(t)v(t) = q\sum_{k=1}^{n} v_k(t) = q\sum_{k=1}^{n}\frac{\mathrm{d}l_k}{\mathrm{d}t} = \sum_{k=1}^{n}\frac{\mathrm{d}p_k}{\mathrm{d}t} = \frac{\mathrm{d}p}{\mathrm{d}t}\,, \tag{2}$$

where n is the number of dipoles and p is the resulting dipole moment.

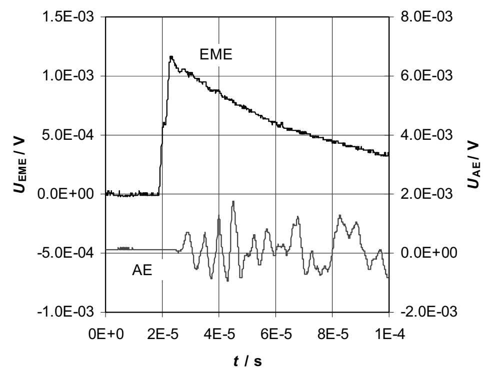

Fig. 1. EME and AE waveforms, extren.

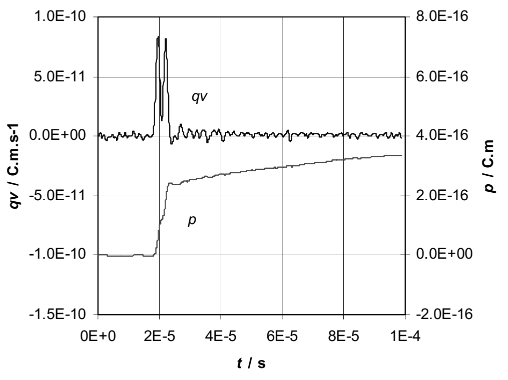

Fig. 2. Quantity qv and dipole moment p.

The present method appears to be a convenient tool for experimental and theoretical studies into the generation and behaviour of microcracks arising during the mechanical stressing of solid dielectric materials.