Geophysical Research Abstracts
Vol. 12, EGU2010-12994, 2010
EGU General Assembly 2010

Memory effects on mechanically stimulated electric signal; diversification of stimuli impact on material memory and comments on the observed features

Panagiotis Kyriazis (1,2), Ilias Stavrakas (1), Cimon Anastasiadis (1), Dimos Triantis (1), and John Stonham (2)

(1) Technological Educational Institution of Athens, Electronics, Athens, Greece (pankyriazis@gmail.com), (2) Brunel University, School of Engineering and Design, Uxbridge, London,UK

Memory is defined as the ability of marble and generally of brittle geomaterials to retain "imprints" from previous treatments and to reproduce information about these treatments under certain conditions, by analogy to the memory of human beings. Memory effects have been observed in the evolution of a variety of physical properties like the acoustic emissions of brittle materials during fracture.

The existence of memory effects for the mechanically stimulated electric signal, either by Pressure (PSC) or by Bending (BSC), is examined in this work, alongside with an attempt to distinguish between the two different manifestations of 'memory' based on the electrification mechanism that is triggered at different levels of externally applied load on samples. Having identified two main mechanisms (i.e. the dynamic and the cracking) and following the human memory model, we suggest the separation of memory of a material specimen into two levels i.e. the short or temporary and long or permanent memory.

For the observation and analysis of the short memory of brittle materials we have conducted experiments using the PSC technique in marble specimens. The materials are imposed to cyclic stepwise loading of the same level, scheme and direction (axial stress – unchanged position of material) in order to comply with the conditions that are proposed as suitable for memory effects study by other researchers. We have also conducted experimental tests of cyclic high level stepwise loading on amphibolite rock specimens in order to verify and study the existence of permanent memory effects.

Modelling the signal recordings and studying the effects of memory on the signals, we have identified certain trends manifestation for the two types of memory that are summarised to the following points. (a) Both types of memory influence the PSC peaks evolution (exponential decrease) in cyclic loadings of the same level. (b) Permanent memory cannot be erased and affects PSC signal permanently and severely. (c) The short memory has temporary influence on the PSC signal and the impacts on the signal are milder.

The main properties of the PSC signal, which are affected by the existence of memory, converge to an inertial attitude of the material to the same stimuli and they are quite common with the properties of other fracture induced signals (i.e. AE). Namely, they are the following: (a) The PSC peak evolution over loading cycles is a changing signal property either in the case of permanent or of temporary memory, with respect to the time interval between events, especially in the latter case. (b) The decrease of the dissipated electric energy during cyclic loading tests. (c) The PSC slower relaxation in each loading, quantified by the relaxation process parameters evolution. (d) The PSC signal response delay in each loading cycle increase

The existence of memory effects on the mechanically stimulated electric signal is an indication that information about the deformation history (paleostresses) of the material reside inside the material. Under certain conditions such information can be revealed by analysis of the PSC signal response to specific external mechanical triggering.