FEM-simulation of crack propagation in linear piezoelectric material

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By far most of the piezoelectric devices nowadays consist of ceramics, which are known as brittle material. Therefore, cracks are a well-known phenomena in piezoelectrics. Of special interest is the question of crack propagation. Numerical Methods which are able to predict if a crack propagates or not, and if propagate which crack path can be expected, are of practical interest in order to design potential endangered devices etc.

Although the cracking process in piezoelectric materials is not completely understood up to now, especially the influence of the electric field to possible cracking criterions in general (see, e.g. [3]), some advances have been made on this topic in the last decades.

In a cooperation project there has been developed a simulation tool, which allows to test different cracking criterions in numerical examples with linear piezoelectric material[1]. At each cracking step an adaptive FEM-solution matching to the actual crack configuration is computed, and in postprocessing a calculation of certain parameters is performed (which are used in cracking criterions to indicate or quantify crack propagation). After a crack increment, the procedure repeats. The basics for the FEM-simulation are explained in some details in [4]. Results of such numerical tests can be compared with results of real experiments under defined loads.

Of course, the assumptions of the model used in the simulation method are a restriction to real-world behaviour of piezoelectric ceramics. Several enhancements might help to lead the simulation closer to reality, as example the assumption of more general than impermeable boundary conditions on the crack faces or the possibility of contact between crack faces have been examined[2] (but complicate the simulation significantly).

References:

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