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A nonlinear thermoelectrical problem based on XFEM for cracked media with heat and electrical exchanges between the crack surfaces

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ABSTRACT

Thermoelectrical problems in a fractured media, arise in many types of engineering problems like in the carbon electrodes in a Hall-Héroult cell [1]. To solve this problem, it is useful to take into account this crack by using eXtended Finite Element Method (XFEM). The present paper deals with transient and nonlinear problems to estimate thermoelectrical field distrbutions in cracked medium.

The finite element approximation is enriched in order to take into account the crack discontinuities due to both jump and the asymptotic near-tip function, using the partition of unity [2]. Thermal and electrical exchanges between crack's lips are, respectively, considered as a function of temperature jump and voltage jump at the crack [3]. Due to the heat generation in the solid and between crack's lips induced by interface resistance, the problem is coupled.

The nonlinear XFEM discretized system, due to the temperature dependence of materials properties and Joule effect, is solved using the Newton-Raphson algorithm. The results obtained are compared to classical finite elements analysis with very fine meshes to represent the crack, and show excellent agreement with the proposed XFEM model proposed in this paper.

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