# Arbitrary crack propagation analysis in polycrystalline materials affected by chemical environment

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## ABSTRACT

The objective of this study is to develop a method of arbitrary crack propagation analysis to assess the residual strength of welded structures subjected to chemical attack. To simulate arbitrary crack propagation, we employ finite cover method (FCM) [1], which is one of the generalized versions of the finite element method, and full automatic mesh generation technique. The FCM has evolved away from the numerical manifold method (NMM) [2], which brings a slightly different understanding of the mathematical domain for approximation from the standard FEM. Here, the domain for approximation is composed of the finite number of covers of differentiable geometry or topology and also endowed with the partition of unity conditions for weight functions (that corresponding to shape functions in the FEM). The important feature of the FCM is that it admits into FE analyses the peculiar elements that in part have a physical domain. Moreover, FCM inherit a very simple but general scheme to represent discontinuity of multiple cracks that physical domain is cut completely by a discontinuous face and then split into two. For this separation of two physical domain, hexagonal element is divided into two polyhedrons and then several tetrahedrons is generated full automatically. On the other hands, we utilize new cohesive zone model whose strength decreases by hydrogen concentration based on absorption hypothesis and a crystal plasticity model to represent the crystallographic slip. Some representative numerical examples are presented to simulate crack propagation accelerated by the hydrogen concentration to assess the residual strength of the overall structure subjected to different environments.

## REFERENCES

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[2] G. H. Shi, *Manifold method of material analysis*, Transactions of the 9$^{th}$ Army Conference On Applied Mathematcs and Computing, Report, No. 92-1, U. S. Army Research Office, 1991.