USE OF COHESIVE ZONE MODELS FOR GRAIN BOUNDARY DECOHESION AND INTRAGRANULAR CRACKING IN METALLIC POLYCRYSTALS

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The use of the Tvergaard and Hutchinson coupled cohesive zone model (CCZM)[1] has been shown to be useful in 2D finite element models of metallic polycrystals with explicit representation of grains for modeling the decohesion of grain boundaries[2] and sub-grain sized particles[3]. A 2D tool set was developed to explicitly model 2D polycrystals with and without sub-grain sized particles to study the initiation of intergranular cracks. The intergranular cracks are allowed to develop naturally by inserting interface elements along the grain boundaries and particle-grain interfaces that follow the CCZM. Cracks initiate based on the surrounding stress and strain fields rather than the explicit introduction by the user. Recent efforts have focused on expanding the current tool set in 2D and transitioning these tools to 3D.

The 2D tool set is continuing to be used to test new capabilities before implementation in 3D. Recent efforts now allow for the transitioning from intergranular cracking to intragranular cracking. This is done by extending the interface elements from a grain boundary junction through a grain if a critical stress is reached in the elements next to the junction.

The previous tools are also being expanded into 3D. 3D polycrystal samples without interface elements have been generated and solved in parallel. These simplified samples contain millions of degrees of freedom verse the tens of thousands for a full 2D sample but have been solved in parallel in a reasonable amount of time. A 3D interface element has been implemented based on the surface element in WARP3D[4]. These elements are easily inserted in the existing 3D polycrystal samples thanks to use of the SQL Database for storage, queries, and retrieval of data. Simulations containing the interface elements are being conducted and compared to the sample without the interface elements.

References

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