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# A centroidal voronoi tessellation based approach of creating grain morphology for crystal plasticity finite element simulations

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## Abstract

A simple approach based on centroidal voronoi tessellation (CVT) is proposed here to create three-dimensional microstructures, for crystal plasticity finite element (CPFE) simulations. The grain morphologies are created for a predetermined grain size. Instead of using the conventional way that generates the grain cells first and then meshes them into finite elements, this new approach discretises the finite element mesh with the grain seeds generated by the CVT method. This new technique prevents the presence of high density mesh at the vertices of irregular grain cells, and can tessellate arbitrary geometry much more easily. Using a scale algorithm, the proposed approach can create any arbitrary microstructure with a given grain size and aspect ratio. For instance, the microstructure shown in Fig. 1 represents a polycrystalline cylinder with a grain size of 150×150×450 $\mu m^3$ (X×Y×Z). More specimens with irregular shapes and containing grains with a range of aspect ratios have been modelled using this new approach. The created grain morphology of a brick shape microstructure containing the experimentally observed grain size and shape is validated by CPFE simulations for aluminium alloys 7075 under cyclic loading. The CPFE simulations successfully predict the hysteresis loops from the beginning to the cyclic saturation for that material, including the Bauschinger effect. It is shown that this proposed approach is simple and efficient.

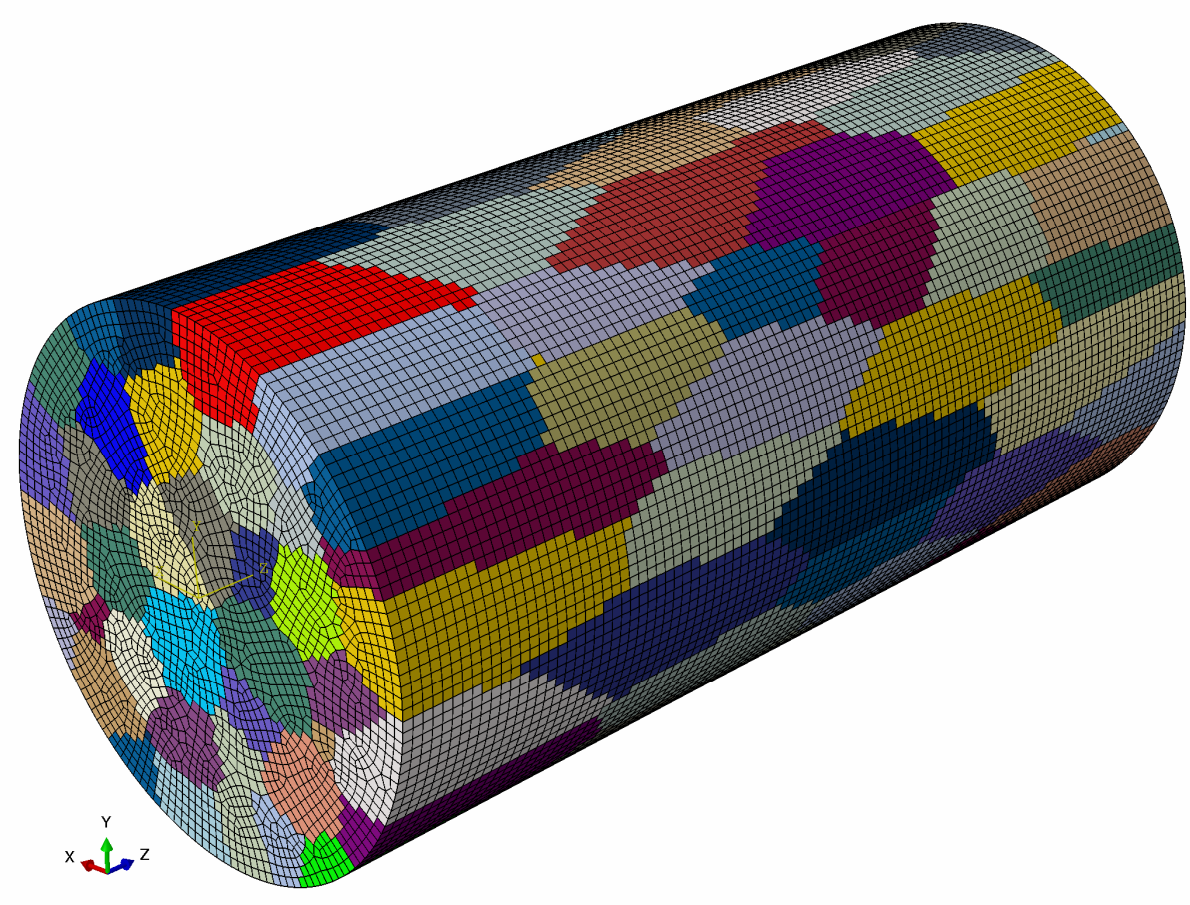


Fig. 1. Crystal plasticity finite element model of a polycrystalline cylinder with the predetermined grain size of 150×150×450 $\mu m^3$ (X×Y×Z). Each colour represents a specific crystallographic orientation.