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CAPTURING POLYCRYSTAL PLASTICITY AND INTERGRANULAR CRACKS WITH A NOVEL DIC METHOD

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1 Introduction

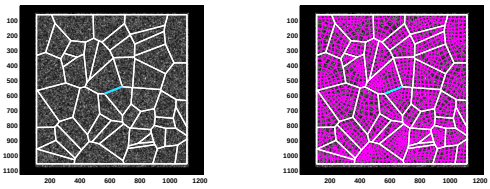
In recent years, we have witnessed an increasing number of important developments in optical full-field measurement techniques. Therefore, the digital image correlation (DIC) method, considered as a representative non-interferometric optical technique, has been widely accepted and commonly used as a powerful and flexible tool for surfacic strain measurements in the field of experimental solid mechanics.

In this paper, a new method which allows to perform the local strain field measurements relying on DIC algorithms will be introduced with a specific treatment of intergranular discontinuities. The aim of this paper is to present and to validate the method on a numerical example associated to cracked polycrystalline aggregate.

2 Numerical Validation and Results

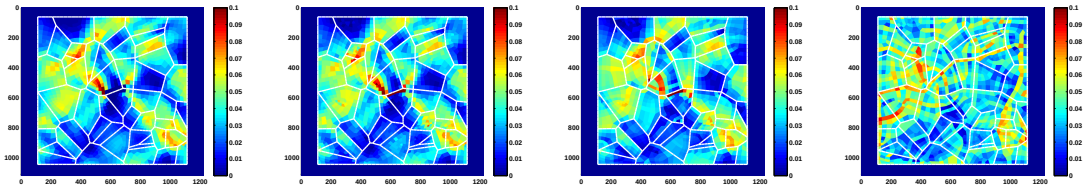
In this abstract, we focus only on the validation procedure. It was chosen to use computer-generated speckle image associated to a completely known strain field. The strain field was obtained by direct crystal plasticity Finite Element (FE) analysis for a given crystal plasticity law [1] and for a given set of boundary conditions, using CodeAster. Afterwards, the simulated displacement field was introduced in the virtual image generation procedure, as described in [2], to mimic the acquisition of speckle images by a digital camera.

In order to determine the correct local strain field, particular care should be taken on the mesh. With a known microstructure (Figure 1a), an unstructured mesh is used in order to represent the grain boundaries (Figure 1b).



(a) Microstructure (b) Unstructured mesh

Figure 1: Microstructure with Unstructured mesh. Initial crack is indicated using a cyan line.



(a) Simulation Aster (b) intra-element continuity (c) intra-granular continuity (d) inter-granular continuity

Figure 2: Equivalent strain fields for the cracked aggregate

The FE computations are performed with the cracked aggregate up to 2% macroscopic strain(Figure 2a), and Figure 2b, 2c, and 2d show Von Mises equivalent strain fields obtained with the proposed method with three different continuity levels.

3 Concluding Comments

The comparison of strain fields calculated by DIC and obtained by FE simulation is conclusive to validate our methodology. Furthermore, this method will be applied to experimental visible images collected during a tensile test on a polycrystalline aluminum sample, which deals with the kinematic data grain per grain in order to establish the relationship between local strain fields and microstructure at grain scale.

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