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Solid Mechanics Master Thesis project At Siemens Industrial Turbomachinery Gas Turbine development department

Title: ***Preliminary life evaluations on polycrystalline alloys using simulations on FE models in which each grain is an anisotropic single crystal and the grains are randomly distributed.***

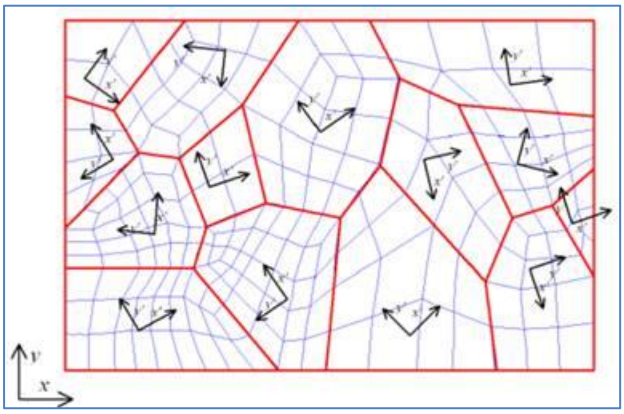

Figure 1: Random distributed grains and orientations

The first target is to understand how the correlation between global and local (on the grain level) strains are affected by e.g. the grain size. Other investigations of interest are also enabled by such FE modeling and may or may not be part of the project depending on how things proceed.

The inspiration comes from a presentation at the recent LCF8 conference in Dresden from which e.g. the figures below were obtained. It is clear that the stress concentrations associated with grain boundaries may be more severe than those from drilled holes, which explains why cracks do not always start at such holes during cyclic testing.

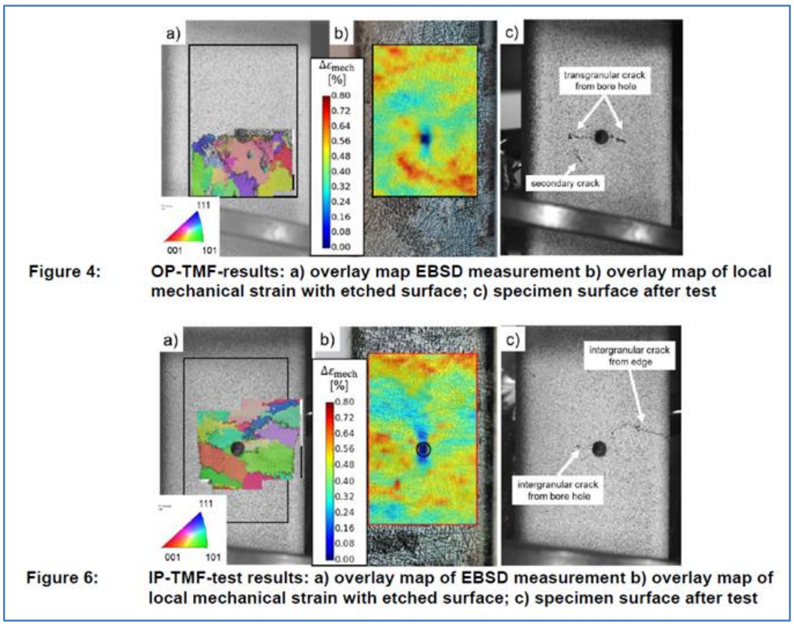

Figure 2: Example of Thermo Mechanical Fatigue testing results

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The task is to run Monte Carlo simulations using a large number of randomly generated polycrystals to study how the strain is distributed. Specifically, we should try to quantify

- the probability of getting strain over a pre-set (high) strain value in a specific volume, and
- the probability of being above a preset (not as high) strain in a specified volume fraction.

The FE models are to be generated with the code Neper.

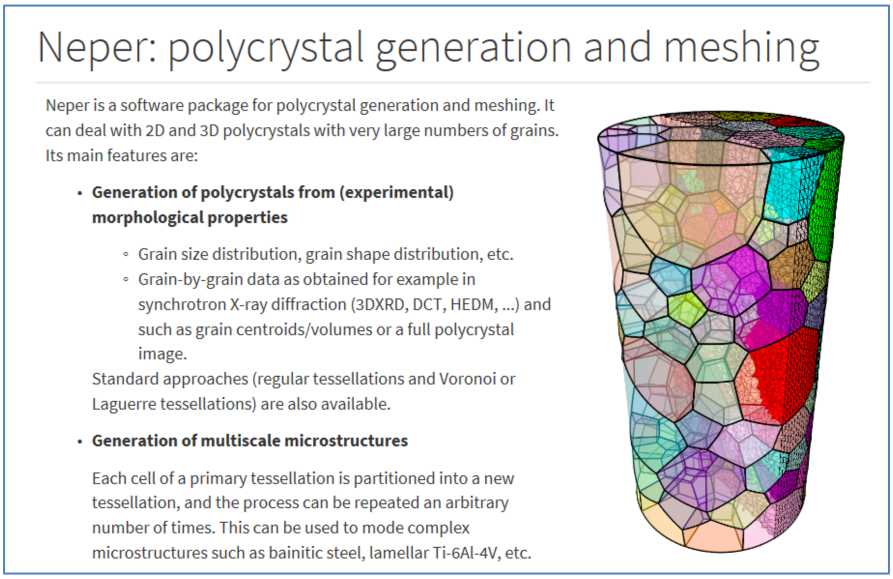

Figure 3: Mesh generation with Neper

Eventually, we hope to be able to estimate the probability that an unfavourable grain boundary is combined with a global strain concentration in a component. This could form the basis for a probabilistic crack initiation model. Such a model could take the measured grain size distribution from a cast component as input (i.e. while the local grain *orientation* is random, the global distribution of grain *size* is 'deterministically governed' by the component geometry and the fixed casting parameters). This would be a physically motivated notch effect model.

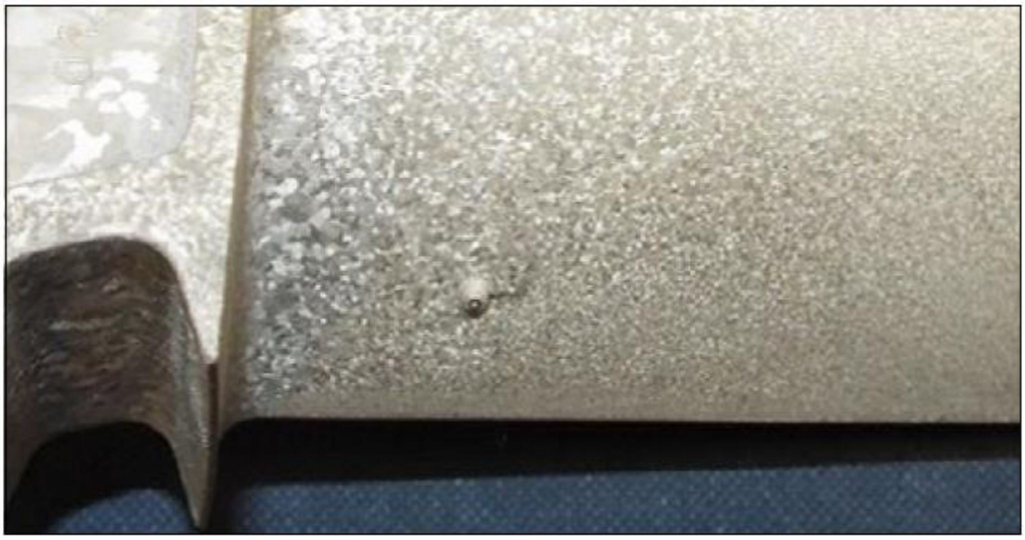

Figure 4: Typical grain size distribution in a cast gas turbine blade

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