Lifetime assessment of welded joints containing defects

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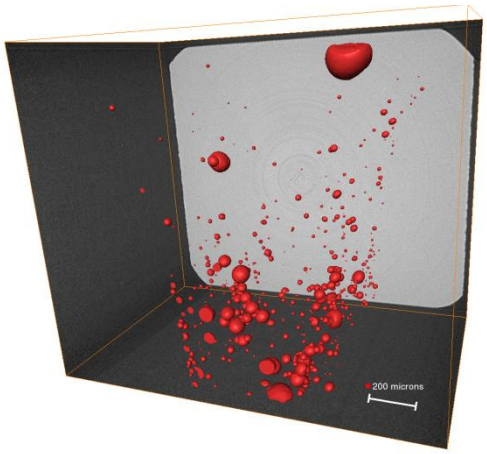

- Cyclic characterization of Ti-6Al-4V welded joints
- Observation of defects with X-Ray computed tomography
- Numerical methods to take into account realistic/real configurations of defects in a mechanical simulation

Abstract:

During the welding of metallic parts, defects may appear. These defects can be detected, localized and measured thanks to the recent improvements in non-destructive testing. Numerical models of structures are generally defect-free or consider some defects with an idealized geometry. This work aims at developing new numerical approaches in order to be able to take defects into account. This PhD thesis focuses on the population of defects observed in autogenous butt-joints in Ti-6Al-4V obtained by Nd:YAG Pulsed Laser Beam Welding, and is divided in 3 main parts.

Firstly, X-Ray Computed tomography experiments will be carried out to observe the population of defects. Based on these data, a statistical modeling of the population will be proposed. This model will be able to render the position, shape, size and orientation of the defects. It will be used to create numerically some realistic configurations that will be inputs for mechanical simulations.

Then, finite element calculations will be carried out systematically to assess the lifetime of structures containing defects. The mechanical behavior of all the zones of the welded joint will be identified on defect-free specimens. Numerical approaches will then be adapted to take into account the stress concentrations and the stress gradients created by the defects. To validate this work, experiments on specimens with controlled defects will be carried out.

Finally, a new numerical approach based on model order reduction will be proposed. It will rely on the combination of simulations of defect-free structures on the one hand and defects embedded in an infinite matrix on the other hand. The objective is to reduce the computational time to less than a day, to make the tool suitable for production timelines.