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# A versatile and fast 3D thermography simulator with open GUI

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**Abstract**

Optical infrared thermography (IRT) has shown significant potential and advantages in defect detection in fiber reinforced polymers(FRPs) due to its capabilities of realizing non-contact and quasi real-time measurements over a large detection area. Simulation of optical IRT is of great importance as it provides support for model-based development, implementation and optimization of the experiment.

To this end, the authors have developed and implemented a versatile and fast 3D simulator, based on finite element (FE) approach, for multi-layer anisotropic materials. In order to model defects, an interface element formulation has been developed which has several advantages over the standard volume element approach. The developed simulator has been benchmarked for different cases with commercial FE software. It is found that our simulator provides identical results, but more importantly, it is shown that the use of interface elements (instead of the standard volume elements) is computationally much more efficient.

To better represent experiments, realistic non-uniform optical heating conditions are also implemented in the simulator. Besides, a stochastic defect modelling technique, on the basis of a morphological approach, is proposed to generate arbitrary, yet realistic, defect geometries. Finally, the fast simulator is programmed in a fully parametrized manner, which makes it suitable for generating large and diverse virtual databases which could be employed for deep learning purposes in thermography. A fully functional GUI module will be made available to the community.

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**Keywords**

FRPs, Non-destructive testing, infrared thermography, Numerical simulation, Finite element method