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ON THE NUMERICAL MODELING AND VALIDATION OF FRACTURE MECHANICS FOR PRINTED ELECTRONICS COMPOSITES

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During the service life of all kinds of structures (e.g. aircrafts, wind turbines) the structural integrity is a key factor for safe performance. Due to the increasing use of fibre reinforced polymers (FRP) in various structures, there is a growing need for timely detection of non-visible damage. Since common scheduled maintenance is ineffective in terms of time and cost, the investigation of possibly viable structural health monitoring (SHM) concepts is a main research focus [1]. Integration of electrical sensors into these structures allows diagnosis about the existence and extent of damage by measuring of in-situ electrical characteristics. Nanojet printed sensors made of carbon nanotube (CNT) enriched composite materials can exhibit considerable electrical and mechanical properties for this task.

As the printed sensors become an integral part of the structure, the effect of the sensor array on the structural integrity is a major design aspect [2]. An optimal array has negligible effects on the load bearing capacity and provides high spatial accuracy in damage monitoring. The mechanical testing of numerous sensor arrays for evaluation is cost and time intensive. In contrast, a validated numerical model of the structure with integrated electronics computes the required information in a cost and time efficient way.

In this work, a finite element model is built that considers individual mechanical properties for the printed sensors which are modeled as cohesive interactions between adjacent substrate materials. The model is validated using experimental test results. Information from the model are used to obtain characteristics for optimized sensor arrays with respect to their effects on the fracture mechanical behavior of the structure.

References

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