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Quantification of material memory using high frequency ultrasonic and microcontinuum physics

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ABSTRACT

After an initial reduction, the composite strength undergoes a dormant state that builds up inside the material, we call material memory. At that stage the distributed damage accumulates at the intrinsic length scales. However, such state does not affect the global strength of the materials. There is no experimental tool that can quantify such material state. Here, we introduce a precursor to damage quantification technique by bridging the gap between multiscale modeling and multiscale sensing. We propose a recently developed parameter called “damage entropy”. It is derived from the understanding of micromorphic behavior of materials where deformation is expressed as sum of macroscopic continuous deformation and internal microscopic deformation. The characteristic length scale evolves during the fatigue life of the composite and their progressive influence changes in a quantified sense thus increase the entropy. We obtained the quantified entropy using quantitative ultrasonic imaging and characterization technique, earlier formulated and applied by the authors. Growth of “damage entropy” is demonstrated in a material under fatigue with no visible damage.