Fatigue Crack Growth Detection Using Material Surface Temperature Analyses

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Prognostics and Health Management (PHM) provides estimates of the Remaining Useful Life (RUL) with reasonable confidence to the decision-makers. Of the possible strategies in successful PHM's, combining damage models from multiple direct or indirect damage measurements is preferable, and the fusion of the damage measurements enhances the confidence in the results of the PHM. In the fatigue damage process, the material dissipates energy in various forms, namely: heat, plastic deformation, and acoustic emission. Among the dissipation modes, heat is measured in temperature increment and monitored during the fatigue process to indirectly infer the amount of fatigue damage, such as crack initiation or growth in a certain length. In this paper, two temperature metrics, i.e., temperature rise and rise rate, were processed from the surface temperature data during fatigue testing of stainless-steel and aluminum specimens. In the experiments, temperature data were collected using a thermocouple attached on the surface close to the crack growth area in the combination of 1000-cyclic loading blocks and the cooling times. The results of these experiments show that the two-damage metrics reach a detectable transition point before the fatigue fracture. Furthermore, the usefulness of this method is assessed in the dependency of material by comparing ferrous and non-ferrous metals.