Material Intrinsic Phenomena Used for Smart Structural Health Monitoring

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ABSTRACT

Engineering structures are prone to damage when being under operation and under the process of ageing. Damage usually occurs locally such as in notches and may then spread gradually around from those. A way on how to understand and model the phenomenon of damage is to transfer the material behaviour in the damage critical area onto a smooth specimen used for materials testing. This of course also requires the material behaviour itself to be understood, such as it is described in terms of fatigue behaviour as the material's related S-N curve. A way on how to get such a curve in a most efficient way has been proposed with the StebLife approach, where a single primarily unnotched specimen is divided into five sections and each of the sections represents a source of the material's information being related to fatigue at different stress levels. This information is retrieved on the basis of parameters conventionally known from non-destructive testing (NDT) such as parameters related to acoustics, temperature or magnetics, which can be monitored with the respective sensors. This information, which is usually even more sensitive than plastic strain, being used as a damage parameter for elastic-plastic materials, can be recorded along the life cycle of a fatigue test of the material or even a component. This information can virtually even be broken down to a pixel level for which histograms can be generated, that allow an ageing process to be described as well as the scattering of material properties, all being an additional important information to reliably predict the residual life of a component considered. Such a way of smart monitoring easily generates a large amount of data that has to be managed accordingly using adequate data management procedures. As a result techniques and technologies developed in the wider context of NDT can be arranged in a 'toolbox' in a way that they can be combined to structural health monitoring (SHM) systems for smart monitoring in the longer term. The way on how to determine a material's fatigue data on the basis of NDT-based parameters to configure an SHM-system on a possibly non-conventional but possibly systematic way will described along the paper.