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MULTIPLE AMPLITUDE TESTING METHOD FOR DETECTION OF LOCAL DAMAGE EVOLUTION IN BAST FIBER-REINFORCED POLYMERS

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ABSTRACT

New resource efficiency requirements create new demands on the materials used. Conventional fiber-reinforced polymers with a thermoset matrix and synthetic reinforcing fibers are creating significant challenges for material recycling and thus for sustainable application. Natural fiber-reinforced polymers with thermoplastic matrix offer high recycling potential as well as lower primary energy consumption in the production of composite material. In particular, natural bast fibers based on flax and hemp can be efficiently cultivated in European agricultural areas, eliminating long transport distances. However, natural bast fibers show a considerable variation in material properties compared to synthetic fibers. The growth condition of the fiber material directly affects material properties such as fatigue strength and damage evolution under fatigue loading.

In multiple amplitude tests, the damage is introduced into the specimen. The stress level is linear increased, which leads to a time-efficient characterization of the fatigue properties. The global damage development is analyzed by acoustic emission. Local effects are monitored by thermography and strain measurement. An additional observation by mechanical energy dissipation allows the detection of the material variance within the sample. Thermography is used to detect areas of intense damage and compare them with areas of low material reaction. To separate the significant damage mechanism, defined sections are taken from the specimen. The introduced damage mechanisms are analyzed by microscopy and computed tomography. The significant differences in damage indicate the relevance of local material properties in terms of fatigue strength and damage evolution.