

Accepted Manuscript

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PII: S0266-3538(16)30542-5

DOI: [10.1016/j.compscitech.2017.01.021](https://doi.org/10.1016/j.compscitech.2017.01.021)

Reference: CSTE 6643

To appear in: *Composites Science and Technology*

Received Date: 17 June 2016

Revised Date: 23 January 2017

Accepted Date: 25 January 2017

Please cite this article as: Tian F, Pan Y, Zhong Z, A long-term mechanical degradation model of unidirectional natural fiber reinforced composites under hydrothermal ageing, *Composites Science and Technology* (2017), doi: 10.1016/j.compscitech.2017.01.021.

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**A long-term mechanical degradation model of unidirectional natural fiber
reinforced composites under hydrothermal ageing**

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Abstract

In this paper, a constitutive model is developed for unidirectional natural fiber reinforced composite materials to describe their mechanical degradations when subjected to long-term hydrothermal ageing. Two internal variables, which reflect the effects of moisture absorption and hydrolysis reaction, are incorporated into the Helmholtz free energy and energy dissipations within non-equilibrium thermodynamic framework. Furthermore, specific forms of modified Helmholtz free energy are employed to study the constitutive behaviors of the composite and the damage evolution laws for hydrothermal ageing processes are established. We then apply the theoretical model to analyze elastic responses of the composite under long-term hydrothermal ageing. The present theoretical predictions are found in agreement with the existing experimental results, which shows that the moisture absorption related damage develops rapidly and reaches a plateau within 20 days, resulting in a sharp decrease of elastic modulus of the composite at the early ageing stage, whereas the evolution of deterioration associated with hydrolysis reaction is at a much slower rate.

Keywords: Natural fiber reinforced composite material; Thermodynamics;

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