A clustering method for analysis of morphology of short natural fibers in composites based on X-ray microtomography

Anna Madra, Jérôme Adrien, Piotr Breitkopf, Eric Maire, François Trochu

PII: S1359-835X(17)30296-8
DOI: http://dx.doi.org/10.1016/j.compositesa.2017.07.028
Reference: JCOMA 4748

To appear in: *Composites: Part A*

Received Date: 31 May 2017
Revised Date: 21 July 2017
Accepted Date: 27 July 2017

Please cite this article as: Madra, A., Adrien, J., Breitkopf, P., Maire, E., Trochu, F., A clustering method for analysis of morphology of short natural fibers in composites based on X-ray microtomography, *Composites: Part A* (2017), doi: http://dx.doi.org/10.1016/j.compositesa.2017.07.028

A clustering method for analysis of morphology of short natural fibers in composites based on X-ray microtomography

Anna Madra[a,c,*], Jérôme Adrien[b], Piotr Breitkopf[a], Eric Maire[b], François Trochu[c]

[a] *Laboratoire Roberval, UMR 7337 UTC-CNRS, Université de Technologie de Compiègne, Centre de Recherches de Royallieu, CS 60319, 60203, Compiègne Cedex, France*
[b] *Université de Lyon, INSA-Lyon, MATEIS CNRS UMR5510, 7 Avenue Jean Capelle, 69621 Villeurbanne, France*
[c] *Chair on Composites of High Performance (CCHP), Mechanical Engineering Department, Center of Research on Polymers and Composites (CREPEC), École Polytechnique de Montréal, Montréal H3C 3A7, Canada*

Abstract

The work presented here concerns the methodology for the analysis of X-ray micro-CT scans of composite materials with a discontinuous phase. An automatized method has been devised for the measurement of geometric features and identification of distinct morphological types. This approach offers new insights into the composition of a microstructure based on the analysis of phase morphology and its relative volume percentage. It stays in contrast to the frequency-based approach that attributes the same importance to all elements of the structure, and is thus biased towards numerous, but not necessarily essential components of the material. The method is general and can be applied to any type of discontinuous, dispersed phase in composites identified with X-ray micro-tomography. We have verified our approach for short natural fibers but it may be of interest for characterizing void distribution in RTM manufactured composites or cracks after failure.

Keywords: A. Natural fibers; B. Microstructures; D. CT analysis; D. Microstructural analysis

1. Introduction

The geometric features of the microstructure of a material are crucial to the understanding of the manufacturing process and prediction of mechanical properties [1, 2, 3]. A good description of the morphology is especially important for materials consisting of or containing discontinuous phase elements. These include alloys with particulate phases, ceramic and metallic foams with cellular structure and composites with short fiber reinforcements. In the latter, the manufacturing process not only influences the spatial distribution and orientation of fibers but can also degrade them.

For example, changes in length and aspect ratio of cellulose fibers have been observed by Puglia et al. [4] during compounding with polypropylene at different fiber volume fractions. Increased amount

*Corresponding author
Email address: annakopov@gmail.com (Anna Madra)