3D TOMOGRAPHY OF INDIVIDUAL FLAX FIBER WITH DIGITAL HOLOGRAPHY

H. KHELFA[1], S. NASRI[2], M. MALEK[1], C. POILÂNE[1, 3], D;MOUNIER[4], P. PICART[1]

1 : LAUM, UMR 6613, CNRS, Université du Maine, Av. O. Messiaen, 72085 LE MANS, France
2 : Unité de Recherche de Physique de l'Etat Solide 01-UR-13-03, Faculté des Sciences de Sfax, SFAX, Tunisie
3 : CIMAP, UMR 6252, CEA, CNRS, Université de Caen Basse-Normandie, ENSICAEN, 14050 CAEN cedex 4, France
4 : IMMM, UMR 6283, CNRS, Université du Maine, Av. O. Messiaen, 72085 LE MANS, France

e-mail : pascal.picart@univ-lemans.fr

Abstract

In a near future, vegetal fibers are involved to be an interesting opportunity in the field of reinforced polymer structures [1]. Traditional synthetic reinforcements are carbon fibers, glass fibers, Kevlar fibers. Vegetal fibers are very different from these latter. Their properties are therefore the subject of many studies under laboratory conditions [2, 3]. Especially, their particular properties of damping were observed but not explicated. We have developed an experimental setup permitting the dynamic investigation of a individual flax fiber. The experimental results need to be completed by a numerical modeling in which one needs to describe the external and internal shape of the fiber along its vertical axis. Such information requires an in situ topographic inspection of the region of interest of the fiber. Individual flax fiber is quite similar to a pure phase object, i.e. a transparent object. Therefore, 3D tomography must be implemented through holographic method which is the only technique able to provide quantitative phase measurement.

We describe a digital holographic setup, able to provide fine experimental data on a individual flax fiber. The setup is coupled to the laser ultrasonic system in order to get simultaneously dynamic information (vibration modes) and local surface/volume shape measurements (3D tomography). The holographic tomographic setup is basically described in figure 1 and is based on the setup proposed by Charrière et al [4]. A blue laser is splitted into a reference and an object beam. The optical setup is a transmission microscope in which the illuminating wave is a plane wave and the object can be rotated along its vertical axis. For each angular position of the fiber we record an off-axis digital hologram of the fiber. The recovering of the amplitude and phase of the fiber is performed according a filtering in the Fourier space (off-axis holography). Then, optical refocusing is computed according to a differential indicator strategy [5]. Each complex field computed for each angular position of the fiber is next inserted in a pile of images which is Radon-transformed in order to get the 3D surface and shape. Our contribution aims to present the full optical setup and the first results obtained on individual flax fibers.

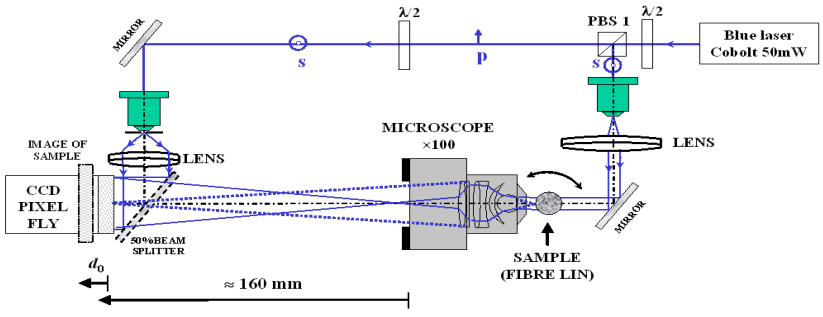

Fig. 1. Digital holographic set-up for 3D tomography.

Références
[1] A.K. Bledzki, J. Gassan, Prog. Polym. Sci. **24** (1999)
[2] K. Charlet, C. Morvan, J. Bréard et al., RCMA **16** (2006)
[3] J. Bréard, M. Gomina, J.-P. Jerbot, RCMA **18**, 2 (2008)
[4] F. Charrière, N. Pavillon, T. Colomb et al., Opt. Expr. **14**, 16 (2006)
[5] Li Xu, M. Mater, J. Ni, Opt. Expr. **19**, 16 (2011)