Materials and Design 32 (2011) 453–461

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Technical Report

# Microstructural, physico-chemical and mechanical characterisation of *Sansevieria cylindrica* fibres – An exploratory investigation

V.S. Sreenivasan [a], S. Somasundaram [b], D. Ravindran [c,*], V. Manikandan [d], R. Narayanasamy [e]

[a] Department of Mechanical Engineering, Dr. Sivanthi Aditanar College of Engineering, Tiruchendur 628 215, Tamil Nadu, India
[b] Government Sidha Medical College, Palayamkottai 627 002, Tamil Nadu, India
[c] Department of Mechanical Engineering, National Engineering College, Kovilpatti 628 503, Tamil Nadu, India
[d] S. Veerasamy Chettiyar College of Engineering and Technology, Puliankudi 627 855, Tamil Nadu, India
[e] Department of Production Engineering, National Institute of Technology, Tiruchirapalli 620 015, Tamil Nadu, India

ARTICLE INFO

*Article history:*
Received 15 March 2010
Accepted 2 June 2010
Available online 8 June 2010

ABSTRACT

The microstructural, physical, chemical and mechanical properties of *Sansevieria cylindrica* fibres are described for the first time in this work. A microstructural analysis of *S. cylindrica* leaves showed the presence of structural fibres and arch fibres. Polarised light microscopy and scanning electron microscopy of these fibres revealed a hierarchical cell structure that consisted of a primary wall, a secondary wall, a fibre lumen and middle lamellae. The cross-sectional area and porosity fraction of the fibre were estimated to be approximately 0.0245 mm$^2$ and 37%, respectively. The fibre density and fineness were approximately 0.915 ± 0.005 g/cm$^3$ and 9 Tex, respectively. An X-ray diffraction and Fourier transform infrared analysis of the fibres showed the presence of cellulose $I_\beta$ with a crystallinity index of 60%. Tensile tests showed that the corrected Young's modulus was approximately 7 GPa, the tensile strength was 658 MPa, and the total elongation was between 10% and 12%.



## 1. Introduction

Environmental awareness groups all over the world have focused their attention on the use of cellulose fibres to reinforce polymer matrixes. The attractive features of natural fibres include their low cost, light-weight, moderate strength, high specific modulus, renewability, biodegradability, lack of health hazards and amenability to chemical modification. Therefore, natural fibre-based composites have good potential for use as building materials. Several authors have reported the use of natural fibres such as palmyra [1], sisal [2], banana [3], oil palm [4], henequen [5], jute [6], hemp [7] and wood pulp [8] as reinforcements in polymer matrixes.

The industrial use of natural fibres as reinforcements in composite materials started at the beginning of the 20th century with the manufacturing of large quantities of sheets, tubes and pipes for electronic purposes. For example, the seats and fuel tanks of aircraft were made of natural fibres with a small content of polymeric binders [9]. When cost-effective synthetic fibres that were less sensitive to temperature and moisture were brought onto the market, natural fibres were largely abandoned in these industries. More recently, stringent environmental regulations and an increased interest in the use of natural resources have led to a positive change among composite industries and end users. Efforts are being made to find alternate reinforcements and resin systems that are eco-friendly and provide the same performance as their synthetic counterparts [10].

Today, a revolution in the use of natural fibres as reinforcements in technical applications is taking place, primarily in the automotive industry. European renewable fibres such as flax and hemp are now used to manufacture door panels and the roofs of automobiles [10]. However, accelerating the substitution of synthetic fibres by natural fibres requires the greater availability of such fibres, and their current production level does not meet today's demand. New plants must be found that enable easy and cost-effective extraction methods that do not impair the properties of the fibre. These new fibres must be analysed to determine their physical, chemical and mechanical properties. Microscopy (either optical or electron) is an invaluable tool to strengthen our knowledge of the morphology of fibres. This knowledge is essential to evaluate or efficiently simulate the properties of these fibres.

In this paper, the *Sansevieria cylindrica* and fibres extracted from it are described. The present study aims to investigate the potential use of *S. cylindrica* fibres (SCFs) as reinforcements in polymeric materials. The physical, chemical and mechanical properties of the SCFs were measured and compared with other natural fibres. A pycnometer was used to assess the density of the fibres, and a

* Corresponding author. Tel.: +91 94432 57441; fax: +91 4632 232749.
*E-mail addresses:* vssreenivasan@ymail.com (V.S. Sreenivasan), pkssomasundaram@yahoo.in (S. Somasundaram), rmkv1@rediffmail.com (D. Ravindran), vaimanikandan@yahoo.com (V. Manikandan), narayan@nitt.edu (R. Narayanasamy).

0261-3069/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.matdes.2010.06.004