

Investigations on Structural Characteristics, Thermal Stability, and Hygroscopicity of Sisal Fibers at Elevated Temperatures

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Interest about the thermophysical properties of plant fibers and their composites have increased due to their important properties of biocompatibility, possible biodegradation, non-toxicity, and abundance. The crystallographic and thermodynamical studies of some major plant fibres such as cotton, flax, jute, ramie, etc. have been carried out by some workers [1-3]. Investigations on thermophysical properties of minor plant fibres that are available in North-East India, however, have not been noticed yet. An effort has been made to study the thermophysical properties in the temperature range about 310 to 760 K of sisal plant fiber, which is available in North-East India. In our studies, we examined the effect of heat on the structural characteristics of the fiber by using XRD and chemical behaviors of the fiber by IR spectroscopy. The thermodynamical studies of the fiber have been carried out using TG, DTG, and DSC methods. The hygroscopic properties of the fiber have been investigated in the temperature range of about 310 to 430 K with different relative air humidities using ordinary Gravimetric analysis. The interplanar spacings of the sample heated at 370 K remained the same with respect to their normal value, but the degree of crystallinity and the crystallite sizes increased slightly. The degree of crystallinity of the sample heated at 450 K dropped by 16.48 % from its normal value, and the corresponding interplanar spacings and crystallite sizes decreased by a small amount. Sample heated at 530 K shows the transformation of the fiber's crystalline structure to an amorphous state. The fiber shows thermal stability up to 500 K and follows two different closely related thermal decomposition processes in the temperature range of approximately 500 to 630 K. Oxygen can lead to combustion of the fibers under study in the temperature range of approximately 710 to 720 K. The IR study of the sample heated at the temperature range from 370 to 600 K provides meaningful data which can be used to ascertain the fibers' decomposition and structural information. The hygroscopicity and water-yielding capacity of the fiber under heated conditions are lower with respect to the value under ambient conditions. The saturation limits of moisture absorption of the fiber per gram vary, and depend on the source as well as on pre treatments of the sample. The sample has approximately 5 % increase in weight due to absorption of water at 20 % relative air humidity. The capillary action of the heated sample is less in respect to the native value.

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