Small-Angle X-Ray Scattering Studies of a Natural Fiber: Agave Cantala

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SUMMARY

Agave cantala, a natural fiber is considered as a densely packed colloidal system belonging to the general micelle system and the well known theories of KRATKY and POROD have been utilized to evaluate some macromolecular parameters of the scattering inhomogeneities in it. The small-angle KRATKY Camera of the latest design has been used for experimental measurements. The parameters evaluated are the specific inner surface, transversal lengths like the length of inhomogeneity and the length of coherence and the air fraction of the scattering particles in Agave cantala fiber; these were found to be $1.8137 \times 10^{-6}$ Å, 375.066 Å, 502.7223 Å, and 0.017%, respectively.

INTRODUCTION

The small-angle X-ray scattering (SAXS) was introduced when it became desirable to detect large lattice spacings of the order of hundreds and thousands of interatomic distances found in some particular minerals and in certain complex molecules such as high polymers or proteins. To satisfy BRAGG's relation ($n\lambda=2d\cdot\sin\theta$) for high values of lattice spacings, the angle of diffraction must be extended to include extremely small angles even up to small fractions of a degree and fortunately the KRATKY Camera (KRATKY and SKALA, 1958) of the latest design can measure the angle corresponding to a BRAGG value of 20.00 Å.

The theory of small-angle scattering was developed by GUINIER (GUINIER, 1937) and subsequently by HOSEMMANN (HOSEMMANN, 1950). KRATKY (KRATKY, 1938, 1963) took account of interparticle interference. POROD (MITTELBECH and POROD, 1965) has given a rigorous theoretical analysis of small-angle X-ray scattering for densely packed colloidal systems.
EXPERIMENTAL

The sample Agave cantala fiber was obtained in its pure form from Sisal Research Station, Indian Council of Agricultural Research, Bamara, Orissa, India. Agaves are now the World's most important leaf fiber and most of the "soft" currency countries have a possibility of earning "hard" currency through exports of this material. Agaves are increasingly industrially utilized for a very wide and varied range of products.

The sample was dewaxed to show a "Hohlraum" character, i.e. the material is packed in layers with free spaces in between. This being a natural fiber, one can proceed with the estimation of parameters from the smeared out scattering curve (RATHO and SAHU, 1971) and can make a pore analysis of the sample.

CuKα radiation from a MACHLETT-A2 diffraction tube, running at 30 KV and 20 mA was monochromatised by a curved crystal monochromator and allowed to pass through a rectangular slit of width 100μ fitted to the KRATKY Camera which is designed with special precautions to eliminate parasitic scattering. The beam is intercepted by the sample which is placed such that the fiber axis is parallel to the length of the primary beam. The time of exposure was varied from 3hr to 6hr. The scattering curve I vs.X (Fig.1) was constructed and the graph I(x)/X^3 vs.X^3 plotted (Fig.2) to determine the run constant K1 and the correction constant K2 which were found to be 3.00x10^-6 and 0.0075752, respectively.

Fig.1: The Scattering Curve Giving the Value of $\tilde{E}$

\[ \tilde{E} = \int_0^{\infty} I(x) \, dx \]

Area = 89.0 cm² × 10⁻²