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Variation of Crystallite Ellipsoids for Varieties of Cotton Fibers Using Whole Powder Pattern Fitting Technique

M.B. Nanda Prakash[1], G. Thejas Urs[1], H.T. Ananda[2], R. Somashekar[1]*

[1]*Department of Studies in Physics, University of Mysore, Mysore - 570 006, Karnataka, India.*
[2]*Department of Physics, Government College, Autonomous Mandya - 571401, Karnataka, India.*

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ABSTRACT
By using wide angle x-ray scattering (WAXS) technique, we have characterized varieties of cotton fibers. The microstructural parameters like crystallite size <D> and lattice strain (g in %) have been computed for varieties of cotton fibers using whole powder pattern fitting technique developed by us. It is observed that the volume of the crystallite shape ellipsoid is more in mcu-5 compared to the other varieties of cotton fibers.

Key words: *WAXS, crystallite size, lattice strain and crystallite shape*

1. INTRODUCTION

One of the most widely used natural fibers is cotton fiber and also an important material used as textile fiber in the world.Cotton fiber is a member of Hibiscus family and botanical name Gossypiumhirsutum or barbadense[1]. Cotton fibers will be cultivated in and around southern states of India such as Karnataka, Andhra Pradesh and Maharashtra. It is a major crop for several countries[2]. Cotton fiber is made up of pure fibrous cellulose. Cellulose is a high polymer consisting of units of anhydro-D-glucopyranose linked through β-1-4 linkages with its empirical formula $[C_6H_{10}O_5]_n$. The value of n (degree of polymerization) ranges from 4000 – 5000 giving a molecular weight 800,000 [3]. One of the earliest polymeric material cellulose has been examined by X– rays[4]. The structure-property relation in cotton fibre is considered to be very important in textile industry. We have used Wide Angle X-ray Scattering (WAXS) to determine the crystallite size and lattice strain[5,6]. In the present work, the variation of crystallites ellipsoid for varieties of cotton fibers within the limited crystalline region and its dependence on their physical parameters has been studied.

2. MATERIALS AND METHODS

2.1. Sample preparation

Cotton fibers are plucked manually after ripening. This cotton is freed from the buds and taken for ginning. It is a process where raw cotton is separated from the seed. After removing the seed it is taken for baling till it became as lint. Raw lint cotton samples from all the eight varities such as Dch32, Dharwar, Mcu5, Kodai, Laxmi, Lra, Shankar and Suvin were used for the study without any additional treatment.

2.2. X-ray diffraction pattern

The cotton samples were made into small bundles and clamped into a sample holder which was then mounted on the goniometer such that the rotational axis was parallel to the fiber axis and perpendicular to the X-ray beam. Here, We have used an imaging plate system (Dip-3200) with dimensions (440 /240) mm^2, which was moved parallel to the axis of rotation. The wavelength of X-ray radiation was 0.71073Å using Mo target. The X-ray generator (RIGAKU) is operated at 50 kV and 32 mA. The time of exposure was kept at 400s. The X-ray diffraction patterns of various cotton fibers recorded is shown in Figure 1.

3. RESULTS AND DISCUSSION

In the X-ray diffraction patterns we observe two Bragg peaks at $2\theta = 8.4^o$ and 9.5^o.The computed microstructural parameters like crystallite size, lattice strain and d spacing of the (hkl) planes are given in Table 1. It is evident that the mcu5 cotton varieties of cotton fibers. From the Table 1, it is fiber has more crystallite area compared to other observed that the lattice strain (g in %) in varieties of cotton fibers is very small. We have projected the variation in crystallite size along different Bragg reflections onto a plane for other varieties of

*Corresponding Author:
Email: rs@physics.uni-mysore.ac.in

cotton fibers as shown in Figure 2. From Figure 2, it is evident that the volume of the crystallite shape ellipsoid in mcu-5 cotton fiber is more than the other varieties of cotton fibers. Hence mcu5 cotton fiber will have more crystallite shape and size when compared to other varieties of cotton fibers [7].

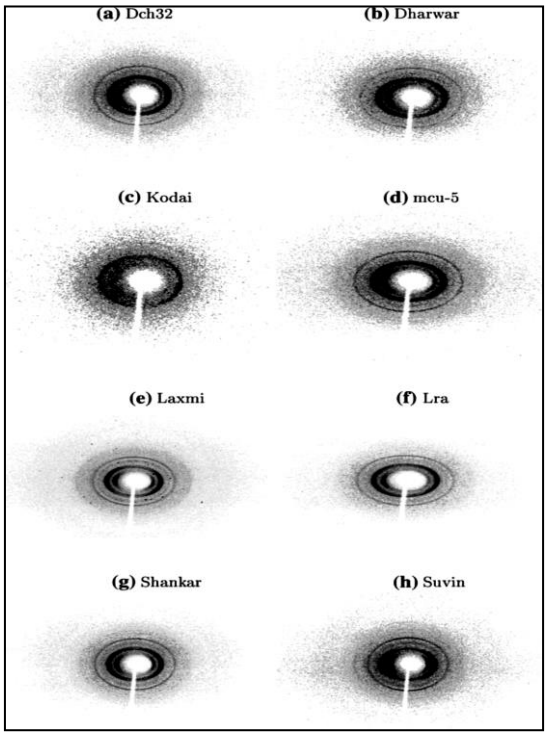

Figure 1. X-ray diffraction patterns of varieties of cotton fibers.

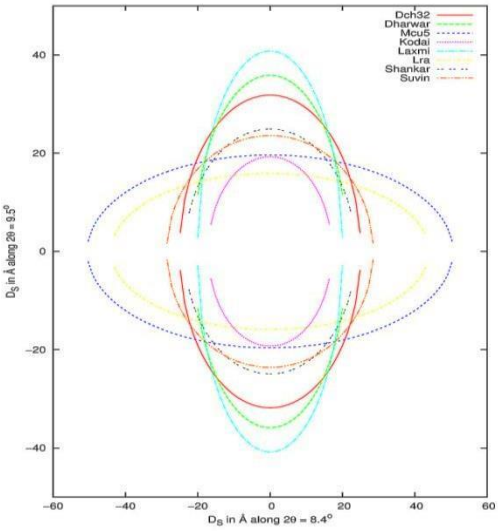

Figure 2. Crystallite ellipsoids for varieties of cotton fibers.

4. CONCLUSION

We have studied the microcrystalline parameters from XRD. It reveals that the volume of the crystallite shape ellipsoid is more in mcu-5 compared to the other varieties of cotton fibers.

Table 1. Microstructural parameters of varieties of cotton fibers.

Samples	g(in%)	N	d_{hkl}(Å)	D (Å)	Crystallite area(Å^2)
Dch 32	0.2 0.1	5.16 7.80	4.85 4.08	25.03 31.82	796.4
Dharwar	0.2 0.2	4.47 8.77	4.73 4.09	21.14 35.87	758.2
Mcu5	0.1 0.1	17.09 19.28	4.62 4.00	50.59 19.63	993.0
Kodai	0.2 0.1	10.41 19.63	4.86 4.09	17.09 19.28	329.4
Laxmi	0.3 0.2	20.05 10.20	4.63 4.00	20.05 40.80	818.0
Lra	0.1 0.1	9.54 3.92	4.61 4.05	43.98 15.88	698.4
Shankar	0.1 0.1	4.78 6.14	4.94 4.06	23.61 24.93	588.5
Suvin	0.1 0.1	28.56 23.58	4.76 4.08	28.56 23.58	673.4

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