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Studies on Effect of Microwave irradiations on DCH-32 Cotton Fibers

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Abstract: **We have studied the influence of microwave irradiation on raw and processed DCH-32 Cotton fibers. The cotton fibers have undergone chemical treatments such as Desizing, Scouring and Bleaching. The effects of such chemical treatment and microwave irradiation on these polymers for different time intervals do affect structural properties of the parent sample. These changes in the microstructural parameters are quantified using X-ray diffraction studies and are reported in this work.**

1. INTRODUCTION

Cotton is cultivated in and around the southern states of India such as Karnataka, Andrapradesh, Maharashtra, Tamilnadu and is a major crop of several countries. Cotton fibres belong to a family of gossypium (Brubaker et at al 1999). Cotton has been used for more than 3000 years because of its versality and good finished products. Cotton is essentially pure cellulosese. The structure- property relation of cotton is considered as an important factor in textile industry.

The use of radio and microwave frequency is gaining importance for industrial applications such as Heating, drying, and other processing. The most important advantage of using microwave is that it is non-contact or localized heating and the heat is produced within the material. This can be much more effective than indirect heating where the heat propagation is by heat conduction through the material. The microwave radiation process is fast, reliable and energy saving.

In the present Investigation, We have studied the influence of microwave radiation at different time intervals on DCH-32 Cotton fibers. Studies are made on raw and processed cotton fibers. The cotton fibers have undergone chemical treatments such as Desizing, Scouring and Bleaching. In the present investigation we have used microwave frequency of 2450 MHz to investigate its effect on DCH- 32 cotton fibers.

Using the method of X-ray Diffraction (XRD) we calculated the changes in crystalline size and Lattice strain. It was found that as the time of treatment under microwave radiation increased from5 min to 20 min Crystalline size of raw cotton was found to decrease. Such structural changes can be highly beneficial for the processing of Cotton fibers in fabric industry.

2. MATERIALS AND METHODS

2.1. Materials:

DCH-32 cotton fibers used in this study are taken from Davangere, Karnataka, Southern region of India. Chemicals for Desizing/ Scouring/ Bleaching included wetting agent, Hydrochloric acid (0.5% concentration), Sodium Hydroxide flakes, Hydrogen peroxide of 100% volume 30% strength, Sodium carbonate and Sodium silicate.

2.2 Preparation of Sample:

Raw cotton was plucked manually after ripening. This cotton was freed from the buds & was taken for ginning. Ginning is a process where raw cotton gets separated from seed. Seed hillsand other small objects. After ginning cotton was taken for baling till it became lint. This lint raw cotton was used for our study.

2.3. Chemical processes; Desizing, Scouring, and Bleaching

Desizing is the process of removing the starch present in the raw cotton fiber which acts as a barrier for absorbing water and chemicals. The cotton fiber was desized with 5% HCL and 3-4 drops of wetting agentusing a liquor ratio of 1:40. The fiber was desized for 90 minutes at 95^{o} C temperature. After desizing the fiber was dried in an oven and then scoured. The process of scouring removes natural impurities such as oils, fats and waxes, which are present in cotton to make it absorbent towards water and dye stuffs. The desized cotton fiber was scoured with 4% NaOH, Na_2CO_3, and 3-4 drops of wetting agent, using a liquor ratio of 1:40. The fiber was

scoured for 90 minutes at 95°C temperature. After scouring the fiber was dried in an oven. The dried samples were then bleached. Bleaching is the process of removal of coloring matter (pigments) present in cotton fiber and to improve the whiteness. The Scoured cotton fiber was bleached for 90 minutes at 95°C temperature in a bath of 2% Na_2CO_3, 10ml of H_2O_2(100 vol, 30%)/1li of water, 15g sodium silicate/lt of water and 3-4 drops of wetting agent.

2.4. Microwave treatment

A commercially available microwave (Godrej make-20l capacity) was used in our study. This has an output power of 800watt, which can be varied by the selection of the knob which determines the percentage of power. The power output of the oven was set for 400watt. The Raw and bleached cotton fibers were exposed to microwave radiations for different time intervals of 5,10,15,20 min. The dosage rate (P x t) for 5min is 5x60x400=120KGy, for 10 min exposure the dosage turns out to be 240KGy, for 15min 360KGy and for 20min it is 480KGy.

3. EXPERIMENTAL

3.1. X-Ray Diffraction Studies:

The cotton samples of required size were takenin the sample holder of Rigaku-Denki miniflex II desktop X-Ray diffractometer with the settings of 30 kV and 15 mA, scanning rate of 5° per minute, and for the range of 5° to 40° with step size of 0.02° being recorded. The integral breadth of the diffraction peaks is related to the apparent size of the crystals and to their microstrains. If the size and strain broadening exist simultaneously, then crystallite size and strain can be calculated by Williamson-Hall plot (W-H plot). For relative comparison of the parameters, WH plot is a reasonably reliable one. The W-H plot considers both limited size of the crystals and the presence of crystallographic distortions which leads to Lorentzian intensity distributions. The slope of the W-H plot represents the average strain in the crystal, whereas intercept with the y-axis gives the crystallite size [2]. TheWilliamson-Hall relation is given by

$$\frac{\beta Cos\theta}{\lambda} = \frac{1}{D} + 4\varepsilon \frac{Sin\theta}{\lambda} \qquad (1)$$

where "β" is the full width at half maximum (FWHM) of the peak measured in radians, "D" is average crystallite size, and "ε" is average lattice strain. The obtained XRD plots and the values of crystallite size and average strain are given in Figure 1, 2 and Table 1 respectively.

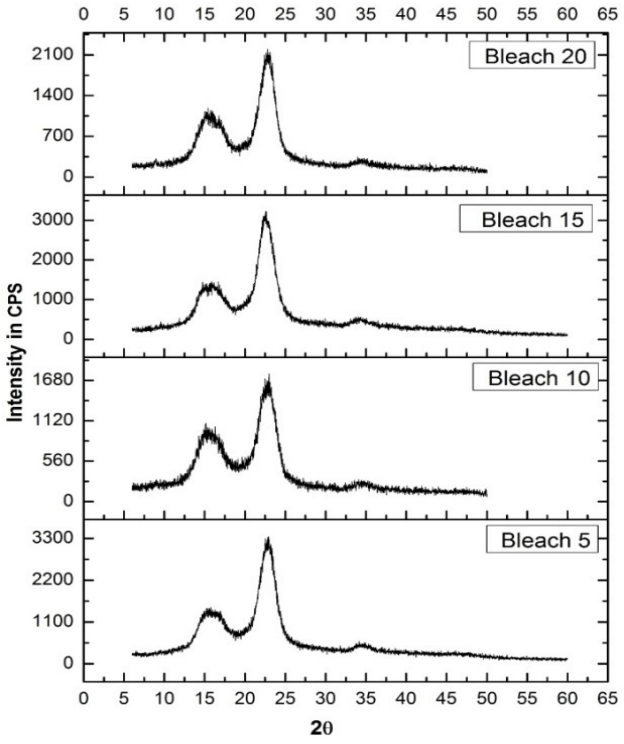

Figure 1: XRD plots obtained for the microwave irradiated raw cotton samples.

Table 1: Microstructural parameters obtained for the samples

Samples	Average Crystallite Size in Å	Average lattice strain in %
Raw	60.68	1.47
After microwave irradiation for various time intervals		
Raw 5	59.78	1.11
Raw 10	58	1.52
Raw 15	57.47	1.36
Raw 20	57.01	1.66
Samples chemically treated		
Bleached	61.76	1.62
Bleached 5	59.24	1.40
Bleached 10	58.80	1.93
Bleached 15	59.39	1.04
Bleached 20	60.87	1.58

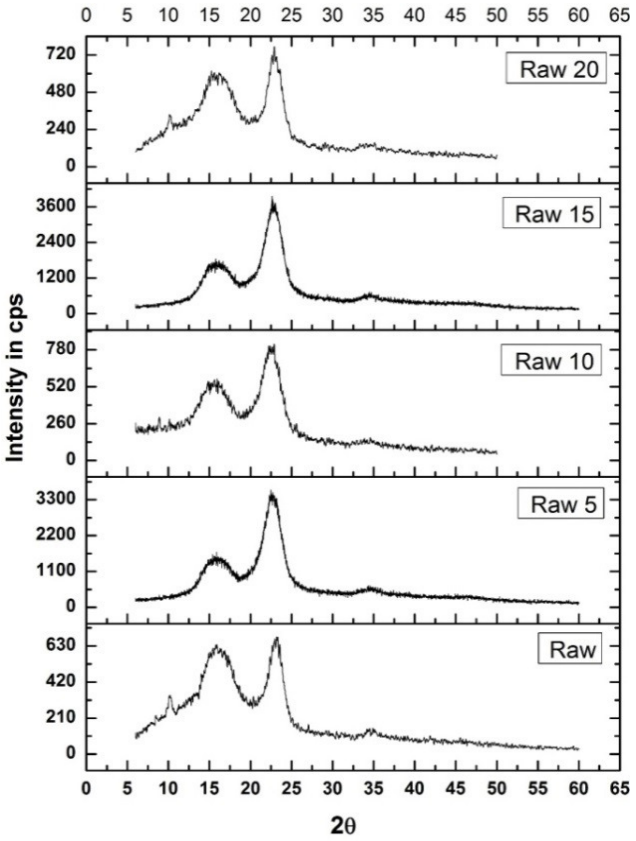

Figure 2: XRD plots obtained for the microwave irradiated bleached cotton samples.

4. RESULTS AND DISCUSSIONS

It is seen from the XRD plots that there is no such significant changes in the diffraction pattern obtained for the irradiated and unirradiated cotton samples at a quick glance, but the microstructural parameters shows the changes. Even though the changes are very small in both irradiated raw and bleached samples, there is overall increase in crystallite size values with decrease in the microwave irradiation. This implies that there is scission of molecular chains leading to more amorphous regions with microwave irradiation. There are earlier reports on man-made fibers that, this behavior is associated with decrease in mechanical properties [3]. Bleached samples show a different behavior wherein the crystallite size decreases initially and then increases. The reason being that a continuous bleaching may change the polymer network leading to a better ordering which leads to a slight increase in the crystallite size.

5. CONCLUSIONS

We have quantified the changes in microstructural parameters in raw and bleached cotton fibers using X-ray diffraction data. Further it is also observed that there a gradual decrease in the values of crystallite size with increase in the dosage of microwave radiation for raw cotton fibers. On the contrary, bleaching has a reverse effect. All these changes are computed by considering the standard deviations involved in the method.

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