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Investigation Studies of Microwave Effect on Structure of Cellulosic Fibers II

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Abstract : Paper sheets were obtained by different types of lignocellulosic fibers. The best-produced paper sheets in part (I) were submitted to accelerate ageing by heating with conventional methods furthermore microwave was used for correlation and research its impact on structure of cellulosic filaments. The property of microwaves, was their ability, under suitable conditions, to produce rapid and uniform heating throughout the material exposed to them. There was a noticeable change had occurred in mechanical properties of paper sheets obtained from cotton linter pulp with time comparing with thatin part (I). The paper obtained from bagasse and mixed pulps deteriorated with time. In the case of paper sheets obtained from wood pulp, deterioration in mechanical properties with time is not taken into account comparing with that submitted to accelerate ageing (part I). In all cases whiteness influenced by submitting paper sheets to accelerate ageing. Examining electron microscopy and infrared spectroscopy had been studied.
Keywords : Papersheets; Infrared spectroscopy; Scanning electron microscopy; Strength properties; Optical properties.

Introduction

The paper is a flexible material with numerous employments. The most well-known are for composing and printing upon; it is likewise generally utilized as a bundling material, in numerous cleaning items, and in various modern and development forms. Permanent paper is the paper that has a reasonable life expectancy exceeding 200 years. Most modern papers have a reasonable life expectancy of about 50 years[1], but durability is the ability of paper to keep its original characteristics in use. Archival paper is an especially permanent, durable acid-free paper. Archival paper is meant to be used for publications of high legal, historical, or significant value. According to the scope of the standard, archival paper is primarily required for documents and publications intended to be kept permanently because of their high historical, legal or other significant values. Archival paper is for special purposes, not for common use. The use of the term "archival paper" does not imply that all papers kept in archives are "archival papers."[2,3]

The best method of measuring the permanence of paper is by natural aging. However, this method is obviously impractical for relatively permanent papers because of the time involved. In order to shorten the time involved, accelerated test methods have been devised which utilize light and heat.[4,5] Heat tests may be used to measure the relative stability of paper, although heating does not always give results comparable to natural

aging because of the dehydration which occurs at high temperatures. In carrying out accelerated aging tests using heat, paper strips are heated in an oven at 105°C. for seventy-two hours and then tested for folding endurance [6].

Likewise[7,8,9], it can be seen that warming by routine means is a moderate procedure, including various stages in the exchange of vitality before the material to be warmth achieves a uniform condition of sub-atomic movement and temperature. The property of microwaves,[10,11] which makes them appealing for color obsession and different uses, is their capacity, under suitable conditions, to create quick and uniform warming all through the material presented to them.[12,13,14]

The aim of the work is to explore microwave impact on the structure of cellulosic filaments furthermore warming by ordinary means.

Experimental

Materials

Cotton linter, bleached bagasse, unbleached bagasse, unbleached mixed (rice straw and 25%bagass), and wood pulps, were used as a base furnish to prepare papers, supplied by Edfo Paper Mill, Upper Egypt.

Paper making

The pulps were beaten in a vally beater at 6% consistency until they reached 45°SR. After paper sheet formation, the papers were conditioned for 24 hr., at 50% RH and 20°C.[15,16] The pulps were chemically analyzed for α-Cellulose, pentosans, lignin, and ash, according to standard methods.[17,18]

accelerate ageing

The produced paper sheets were submitted to accelerate ageing at 100°C for 144hr. It is said that 144 hr. would be equivalent to 50 years under encompassing conditions[6,19,20]furthermoremicrowave (2hr. at 450 watts) had been used.[21,22] Sheets had been subjected to the following tests:

Mechanical properties

Mechanical properties of the paper, namely tensile strength, breaking length and burst strength had been measured[17].

Physical Properties

The physical property of the produced paper sheets namely whiteness had been measured by using Ultra Scan Pro Hunter lab(w1 E13[D65/10]).

Infrared spectra

The infrared spectra for treated and untreated prepared papers fiber were measured by using Fourier transform infrared spectrometer (FT/IR-6100, Jasco, Japan). All spectra were recorded in the range (4000 – 400 cm^{-1}), the number of scans was 128, and the resolution was 4 cm^{-1} and scan speed 2 mm /s. Infra-red spectra of the papers fiber were obtained in reflection % to analyze the chemical composition.

Scanning electron microscopy:

Scanning electron microscopy (SEM) was conducted on JEDL JEM-100S electron microscope using the gold – Sputtering technique.

Results and Discussion

The chemical analysis of raw materials was given in Table (1).

Mechanical and physical properties of untreated paper sheets.

Table (2) shows mechanical(tensile strength, breaking length and burst strength) and physical properties(whiteness%) of untreated paper sheets which prepared from (bleached and unbleached bagasse, unbleached mixed (rice straw and 25%bagass), cotton linter and wood) pulps. From this Table, it is clear that paper sheets prepared from bagasse and wood pulps gave best results in mechanical properties, this can be attributed to the different chemical composition of pulps. But in the case of physical properties (whiteness%), paper sheets prepared from cotton linter pulp gave best results.

Mechanical and physical properties of paper sheets submitted to quicken maturing at 100°C for 144 hr., furthermore by utilizing microwave(2hr. at 250watts)

It was observed that heating by conventional means is a slow process, involving a number of stages in the transfer of energy before the material to be heat reaches a uniform state of molecular activity and temperature. The property of microwaves[10,11], which makes them attractive for dye- fixation and other uses, is their ability, under suitable conditions, to produce rapid and uniform heating throughout the material exposed to them[12,13,14].

The best- produced paper sheets in part (I) [23]were submitted to accelerate ageing at 100°C for 144 hr. It is said that 144 hr. would be equivalent to 50 years under surrounding conditions furthermore microwave (2 hr. at 450 watts) was used for correlation and research its impact on the structure of cellulosic fibers. FromTables (3,4) there was a noticeable change had occurred in mechanical properties of paper sheets obtained from cotton linter pulp with time comparing with untreated and that submitted to accelerate ageing at 100°C for 72 hr.; 2hr. at 270 watts(part I). The paper obtained from bagasse (bleached or unbleached) and mixed pulps deteriorated with time. In the case of paper sheets obtained from wood pulp deterioration in mechanical properties with time is not taken into account comparing with that submitted to accelerate ageing (part I)this can be attributed to the different chemical composition of pulps.[23,24]In all cases whiteness influenced by submitting paper sheets to accelerate ageing, but this observed clearly in the case of paper sheets obtained from unbleached pulps which contain lignin. Lignin is particularly sensitive to light and undergoes a photochemical reaction in sunlight leading to a darkening of the lignin.[23]

Infrared spectroscopy

Table (5) shows the ratio A1435 cm^{-1}/ A900 cm^{-1} which represents the crystallinity index for the paper sheets made from different pulps. In all cases of paper sheets, crystallinity index diminished when paper sheets submitted to accelerate ageing at 100°C for 144hr. furthermore, when paper sheets submitted to accelerate ageing utilizing microwave (2hr. at 250watts) contrasting with the untreated sheet and that submitted to accelerate ageing (part I). This illustrated in Figure(1).

Scanning electron microscopy of different samples

From photographs of Fig.2(a-l),it had been observed that in all cases adhesion between the fibers slightly decreased with time and this observed clearly in paper sheets obtained from bagasse (bleached and unbleached), cotton linter and mixed pulps, comparing with that paper sheets which submitted to accelerate ageing at 100°C for 72 hr. furthermore by utilizing microwave(2 hr. at 270 watts). But not occurred inthecase of paper sheets obtained from wood pulp, where deterioration of paper sheets is not taken into account comparing with that submitted to accelerate ageing (part I),this can be attributed to the different chemical composition of pulps[23].

Table(1): Chemical analysis of different pulps.

Type of pulp	Lignin %	Pentosan %	Alpha Cellulose %	Ash %
Unbleached bagasse	5.4	25.6	69.0	0.9
Bleached bagasse	0.9	24.0	67.2	0.8
Unbleached mixed (rice straw and 25% bagasse)	1.9	23.9	72.5	1.6
Wood	traces	9.0	89.5	0.5
Cotton linter	0.5	1.5	96	1.0

Table(2): Mechanical and physical properties of untreated paper sheets.

Type of paper	Mechanical properties			Physical properties
	Tensile strength, kg	Breaking length, m	Burst strength, kg/ Cm^2	Whiteness %
Paper made from unbleached bagasse pulp	2.500	2450.980	1.0	25.89
Paper made from bleached bagasse pulp	2.250	2205.882	0.9	43.39
Paper made from unbleached mixed (rice straw and 25% bagasse) pulp	1.700	1666.666	0.8	14.51
Paper made from Cotton linter pulp	1.300	1274.510	0.6	60.51
Paper made from Wood pulp	3.500	3431.373	2.6	53.70

Table(3): Mechanical and physical properties of paper sheets submitted to accelerate ageing at 100°C for 144hr.

Type of paper	Mechanical properties			Physical properties
	Tensile strength, kg	**Breaking length, m**	**Burst strength, kg/ Cm^2**	**Whiteness %**
Paper made from unbleached bagasse pulp	2.150	2107.843	0.9	14.50
Paper made from bleached bagasse pulp	1.410	1382.353	0.7	36.09
Paper made from unbleached mixed (rice straw and 25% bagasse) pulp	1.210	11862.745	0.5	9.78
Paper made from Cotton linter pulp	0.700	687.274	0.6	48.37
Paper made from wood pulp	3.900	3822.792	2.0	47.41

Table(4): Mechanical and physical properties of paper sheets submitted to accelerate ageing using microwave (2hr.at 450 watts).

Type of paper	Mechanical properties			Physical properties
	Tensile strength, kg	Breaking length, m	Burst strength, kg/ Cm^2	Whiteness %
Paper made from unbleached bagasse pulp	2.200	2190.829	1.0	14.00
Paper made from bleached bagasse pulp	1.500	1251.098	0.5	36.99
Paper made from unbleached mixed (rice straw and 25% bagasse) pulp	1.200	1124.568	0.5	8.19
Paper made from Cotton linter pulp	0.800	690.000	0.5	49.00
Paper made from wood pulp	3.800	3687.668	2.2	48.00

Table(5): The ratio A1435cm^{-1}/ A 900 cm^{-1} which represents the crystallinity indexes for the paper sheets made from different pulps

Type of paper	Untreated paper sheets	Treatment of paper sheets at 100°C for 72 hr.	Treatment of paper sheets at 100°C for 144 hr.	Treatment of paper sheets using microwave (2 hr. at 270 watts)	Treatment of paper sheets using microwave (2 hr. at 450 watts)
Paper made from unbleached bagasse pulp	0.650	0.815	0.642	0.653	0.649
Paper made from bleached bagasse pulp	0.935	1.023	0.720	1.237	0.630
Paper made from unbleached mixed (rice straw and 25% bagasse) pulp	1.098	1.158	1.047	1.006	1.000
Paper made from Cotton linter pulp	2.303	2.411	2.000	2.509	2.060
Paper made from wood pulp	1.312	1.315	1.132	1.677	1.239

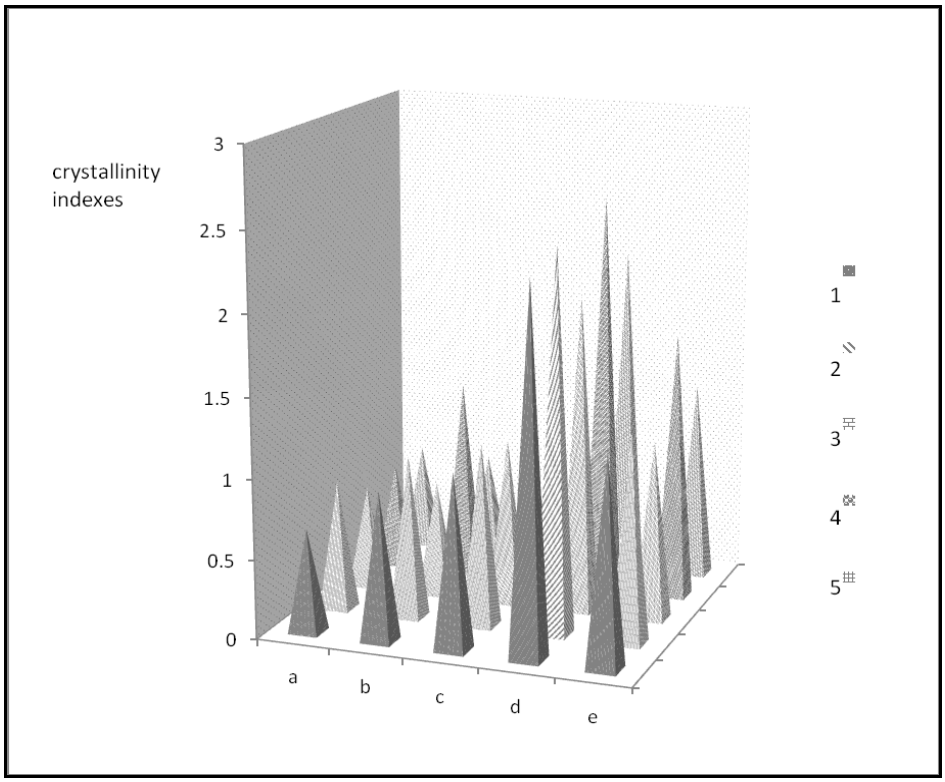
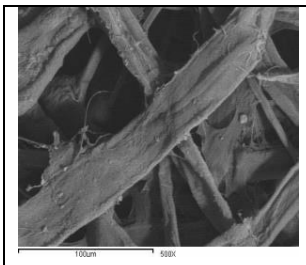
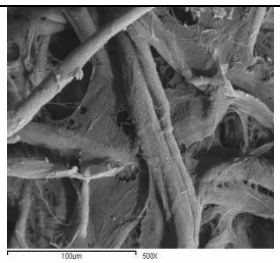
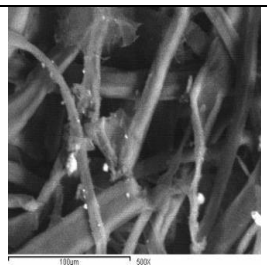
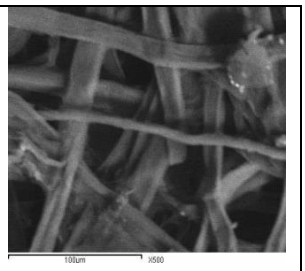
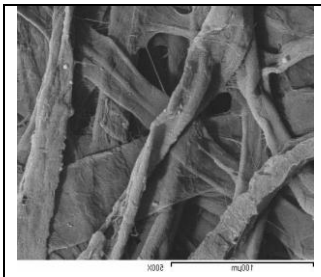
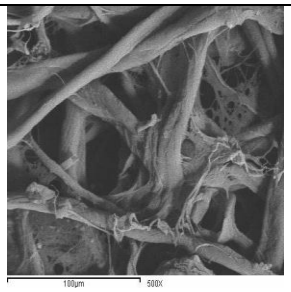
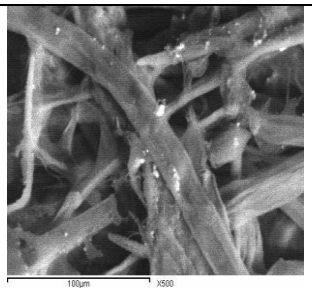
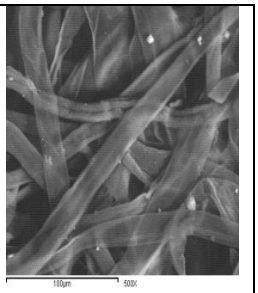


Figure (1) Crystallinity indexes for the paper sheets made from different pulps where, (a) paper made from unbleached bagasse pulp, (b) paper made from bleached bagasse pulp,(c) paper made from unbleached mixed (rice straw and 25% bagasse) pulp, (d) paper made from cotton pulp, (e) Paper made from wood pulp, (1) untreated paper sheets, (2) treatment of paper sheets at100°C for 72 hr.,(3) treatment of paper sheets at100°C for 144 hr.,(4) treatment of paper sheets using microwave (2 hr. at 270 watts), (5) treatment of paper sheets using microwave (2 hr. at 450 watts).

			
Wood paper made from pulp (untreated) (d)	paper made from cotton linterpulp (untreated) (c)	paper made from Bleached bagasse pulp (untreated) (b)	paper made from unbleached bagasse pulp(untreated) (a)

			
paper made fromwood pulp submitted to accelerate ageing at 100°C for144 hr.(h)	paper made from cotton linterpulp submitted to accelerate ageing at 100°C for144 hr.(g)	paper made from Bleached bagasse pulp submitted to accelerate ageing at 100°C for 144hr.(f)	paper made from unbleached bagasse pulpsubmitted to accelerate ageing at 100°C for 144hr.(e)

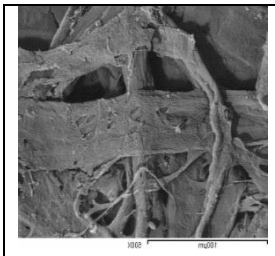
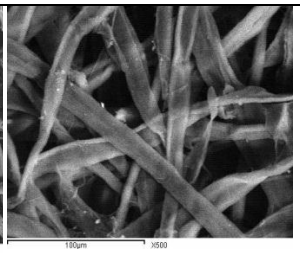
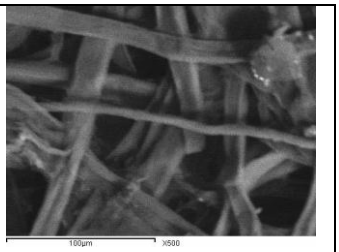
			
paper made from wood pulp submitted to accelerate ageing (using microwave 2hr. at 450watts) (l)	paper made from cotton linter pulp submitted to accelerate ageing (using microwave 2hr. at 450watts) (k)	paper made from bleached bagassepulp submitted to accelerate ageing (using microwave 2hr. at 450watts) (j)	paper made from unbleached bagasse pulp submitted to accelerate ageing (using microwave 2hr. at 450watts) (i)

Figure (2) Scanning electron microscopy of different samples (a-l)

Conclusion

It was observed that heating by conventional means is a slow process, involving a number of stages in the transfer of energy before the material to be heat reaches a uniform state of molecular activity and temperature. The property of microwaves, which makes them attractive for dye- fixation and other uses, is their ability, under suitable conditions, to produce rapid and uniform heating throughout the material exposed to them.

There was a noticeable change had been occurred in mechanical properties of paper sheets obtained from cotton linter pulp with time comparing with untreated and that submitted to accelerate ageing (part I). The paper obtained from bagasse (bleached or unbleached) and mixed pulps deteriorated with time. In the case of paper sheets obtained from wood pulp, deterioration in mechanical properties with time is not taken into account comparing with that submitted to accelerate ageing (part I). In all cases whiteness influenced by submitting paper sheets to accelerate ageing, but this observed clearly in the case of paper sheets obtained from unbleached pulps**.** Scanning electron microscopy proved all of the above. From scanning electron microscopy, it had been observed that in all cases adhesion between the fibers slightly decreasedwith time and this observed clearly in paper sheets obtained from bagasse (bleached and unbleached),cotton and mixed pulps. But doesnot occurred in the case of paper sheets obtained from wood pulp, where deterioration of paper sheets is not taken into account comparing with that submitted to accelerate ageing (part I), this can be attributed to the different chemical composition of pulps. Also from infrared spectra, the ratio A 1435 cm^{-1}/ A 900 cm^{-1} represents the crystallinity index for paper sheets made from different pulps,it had been observed that in all cases of paper sheets, crystallinity index decreased when paper sheets submitted to accelerate ageing comparing with untreated sheet and that submitted to accelerate ageing (part I).

References

1. Houssni E., Altaf H. and Mona M., Permanence of Paper 1. Problems and permanency of Alum–Rosin Sized Paper Sheets from Wood pulp. Restaurator, 1998, 155-171.
2. Ivar A. and Hoel l., Standards for permanent Paper. 64th IFLA general Conference Programme and Proceedings.Archive .ifla. Org. Retrieved, 2009, 06, 24.
3. Dahlo R.,TheRationle of Permanent Paper. In W. Manning &V. Kremp(Eds.) IFLA Publications 91: A Reader in preservation and Conservation. 58. Munchen:K.G.Saur, 2000.
4. Shahani C., Hengemihle H. and WebergN.,The Effect of Variations in Relative Humidity on the Accelerated Aging of Paper. American Chemical Society, 1989, 63-79.
5. Stroefer H., Experimental Measurement: Interpreting, Extrapolation and Prediction by Accelerated Aging. Restaurator, 1990, 11(4): 254-266.
6. Altaf H., Hossni E., Samar H. and Samya E., The role of neutral rosin- alum size agent in production of permanent Paper. Restaurator, 2006, 27, 67-80.
7. Rehab M. Ali and Akmal S. Gaballa. Studying the Functional Properties of Linen Fabrics Treated with Microwave and Natural Green Dyes, International Journal of ChemTech Research, 2014,15, 07(01): 119-130.
8. Farjana Begum A., Chittibabu S., Microwave Assisted lime pretreatment of banana pseudostem for ethanol production, International Journal of ChemTech Research, 2014-2015, 7(5), 2287-2295.
9. LaeliKurniasari, Renan Subantoro, Indah Hartati, Process Optimization of Microwave Assisted Lime Pretreatment on Ramie Decortication Waste Using Response Surface Methodology, International Journal of ChemTech Research, 2016, 9(02): 272-277.
10. Indah Hartati1 and EndahSubekti. Microwave Assisted Extraction of Watermelon Rind Pectin, International Journal of ChemTech Research, 2015, 8 (11): 163-170.
11. Rehab M. Ali and Akmal S. Gaballa, Studying the Functional Properties of Linen Fabrics Treated with Microwave and Natural Green Dyes, International Journal of ChemTech Research, 2014-2015, 7 (01): 119-130.
12. Motasemi, F., Afzal, M.T., A review On the microwave assisted pyrolysis technique. Renov. Sustain. Energy Rev.,2013, 28,317-330.
13. Gawande M. B., S. N. Shelke, R. Zboril and R. S. Varma, Microwave-Assisted Chemistry: Synthetic Applications for Rapid Assembly of Nanomaterials and Organics, ACC. CHEM. RES.,2014, 47, iss. 4, 1338-1348.

14. Ravoof S. A., K. Prateepa, T. Supassri, and S. Chittibabu, Enhancing enzymatic hydrolysis of rice straw using microwave-assisted nitric acid pretreatment, International Journal of Medicine and Biosciences,2012, 1(3): 13–17.
15. El-Saied H., Basta A.H. & M.M. Abdou, Permanence of paper II: Correlation between paper permanence from straw and ageing variables. Restaurator, 2000, 21: 158.
16. Basta, A. H., The role of chitosan in improving the ageing resistance of rosin sized paper. Restaurator, 2003, 24, 106.
17. Casey, J. P., Paper testing and converting in pulp and paper (3rd ed.). New YourkInterscience Publisher, 1981, 1714–1965.
18. Basta, A.H., Performance of improved polvinyl alcohol as ageing resistance agent of rosin sized paper and in restoration purpose. Restaurator,2004, 25, 129-140.
19. Kirova,Kn.L.,I.A.Stepanova, D.M.Flyate&I.S. Shul,man, Kinetic stdies in the ageing of papyrus. Problemy Sokhraunosti Documen-talnykhMaterialov.Leningrad, 1977, 13.
20. Rozmarin, Gh.,Ageing of fibrous cellulose materials. Cellulzasi Hirtie, 1961, 10:428.
21. AiqinHouXiaojun Wang, Lianghua Wu, Effect of microwave irradiation on the physical properties and morphological structures of cotton cellulose, 2008, 74, 934–937.
22. Breitwieser D, Moghaddam MM, Spirk S, Baghbanzadeh M, Pivec T, Fasl H, Ribitsch V, Kappe CO., In situ preparation of silver nanocomposites on cellulosic fibers –Microwave vs. conventional heating. Carbohydrate Polymers,2013, 94, 677– 686,
23. Samar H. Mohamed, Monazah G. Khafagi, Zenat A. Nagieb and El-Samahy M. A., Investigation Studies of Microwave Effect on Structure of Cellulosic Fibers (part I). International Journal of Advanced Research,2014, 2, Issue 6, 129-138.
24. Samar H. Mohamed, Zenat A. Nagieb and Magda G. El-Meligy, Enhanced optical, chemical and mechanical properties for different cellulosic fibers treated by different concentrations of polymers. International Journal of Advanced Research,2015, 3, Issue 6, 880-893.

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