



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 3, March 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com



Application of Fourier Transform Infrared (FTIR) Spectroscopy on Human Hair

Boopathi. M

Assistant Professor, Department of Physics, Meenakshi Ammal Arts and Science College, Uthiramerur,
Tamil Nadu, India

ABSTRACT: Fourier transform infrared spectroscopy (FTIR) has been extensively used in the study of biomaterial like human hair. In this paper, I focus two different applications of FTIR on human hair. FTIR may be utilized to differentiate the dyed hair samples of two different years and another application of FTIR is used to discover the difference among the hair samples of twins.

KEYWORDS: FTIR, ATR, Dyed Hair, Twins

I. INTRODUCTION

FTIR has emerged as a useful tool for monitoring the composition of solids, liquids and gases and the most common use is in the identification of unknown materials and confirmation of production substances (1). Surface properties of solid or thin films can be measured by the application of ATR (Attenuated Total Internal Reflection) (2, 3).

(i) Hair dyeing is manner of life for many people and the hair dye offers other advantages like coloring. Hair coloration protects the hair from environmental hazards and hair evaluation can provide vital facts concerning important chemical substances that may be within the body. Hair is also a crucial biomaterial primarily composed of protein, drastically alpha-keratin (4, 5, 6, 7). In addition to water, the elements that compose the chemical composition of hair are: keratin, lipids, Minerals and pigments (8). Keratin is a protein found in the cortex and it is composed of 18 amino acids. The four most common classifications of hair coloring or hair dyeing are permanent, demi-permanent, semi-permanent, temporary (9, 10, 11, 12).

(ii)Twins provide a treasured supply of information for health and intellectual studies. Same twins referred to as monozygotic, have precisely the identical genes. Equal twins can develop diffused differences. Non-equal twins, also known as fraternal twins, are crucial too (13). Equal twins have distinctive hair and eye color. Fraternal twins, on the alternative hand, can have different hair color. In the present investigation, FTIR technique can be used to locate the distinction between the twins.

II. MATERIALS & METHODS

(i)Two hair samples were collected from 10 years and 15 years dyed male persons. These hair samples were washed with purified water and used to study FTIR-ATR spectrum. The spectrum of the hair samples were recorded in the range of 4000cm^{-1} to 400cm^{-1} .

(ii)The hair samples of twins were collected from 17 years aged persons (male). These hair samples were washed with purified water and FTIR spectrum were taken for these samples using ATR technique in the range 4000cm^{-1} to 400cm^{-1} . All spectral measurements were taken at Sophisticated Analytical Instrument Facility (SAIF), IIT, Madras.

III. RESULTS & DISCUSSION

Fig 1,2,3 and 4 show FTIR spectra of human hair of 10 years dyed person, 15 years dyed person, twin A & twin B respectively. This spectrum reveals a series of bands of different intensities. Table 1,2,3 and 4 present the data on the wave numbers and vibrations of different functional groups for 10 years aged person, 15years aged person, twin A and twin B respectively.

(i)The peaks 523.59 cm^{-1} , 1431.05 cm^{-1} in sample-I with low transmittance values were compared with the peaks 525.84 cm^{-1} , 1454.54 cm^{-1} in sample-II which indicates that more lipids and proteins present in sample-I than sample-II. Less amount of glucose and carbohydrates present in sample-I is due to the peaks 1591.61 cm^{-1} , 3000.60 cm^{-1} with high transmittance values by comparing with the peaks 1525.59 cm^{-1} , 2919.44 cm^{-1} in sample –II. Peaks 523.59 cm^{-1} , 1431.05 cm^{-1} , 1591.61 cm^{-1} , 3000.60 cm^{-1} in sample-I were slightly shifted towards 525.84 cm^{-1} , 1454.54 cm^{-1} , 2919.44 cm^{-1} in sample-II which indicates that the change in the structure of lipids, proteins, glucose in sample-I and sample-II.

(ii)The peaks 3276 cm^{-1} , 2292 cm^{-1} in twin A and the peaks 3275 cm^{-1} , 2309 cm^{-1} in twin B have more or less equal transmittance values. This represents the equal amount of lipids and proteins in twin A and B. Peaks 2920 cm^{-1} , 2853 cm^{-1} , 2106 cm^{-1} , 1982 cm^{-1} , 1630 cm^{-1} , 1531 cm^{-1} , 1459 cm^{-1} in twin A with high values of transmittance were compared with the peaks 2918 cm^{-1} , 2852 cm^{-1} , 2107 cm^{-1} , 1930 cm^{-1} , 1630 cm^{-1} , 1534 cm^{-1} , 1460 cm^{-1} in twin B which indicates that the low value of lipids and proteins in twin A.

The peaks 1234 cm^{-1} , 1044 cm^{-1} in twin A with less value of glucose and carbohydrates were compared with the peaks 1236 cm^{-1} , 1041 cm^{-1} in twin B. Peak 664 cm^{-1} in twin A has low value of CO_2 absorption and NH_2 compared with the peak 658 cm^{-1} in twin B. Peak 521 cm^{-1} (twin A) refers same value of halogen compound with the peak 520 cm^{-1} (twin B). The extra peak arises only in twin A at 581 cm^{-1} .

The peaks 3275 cm^{-1} , 2918 cm^{-1} , 2852 cm^{-1} , 2309 cm^{-1} , 2107 cm^{-1} , 1930 cm^{-1} , 1534 cm^{-1} , 1460 cm^{-1} , 1236 cm^{-1} , 1041 cm^{-1} , 658 cm^{-1} , 520 cm^{-1} in twin B were slightly shifted towards the peak values 3276 cm^{-1} , 2920 cm^{-1} , 2853 cm^{-1} , 2292 cm^{-1} , 2106 cm^{-1} , 1982 cm^{-1} , 1531 cm^{-1} , 1459 cm^{-1} , 1044 cm^{-1} , 664 cm^{-1} , 521 cm^{-1} in twin A which indicates that change in the structure of lipids, proteins and glucose in twin A and twin B hair samples.

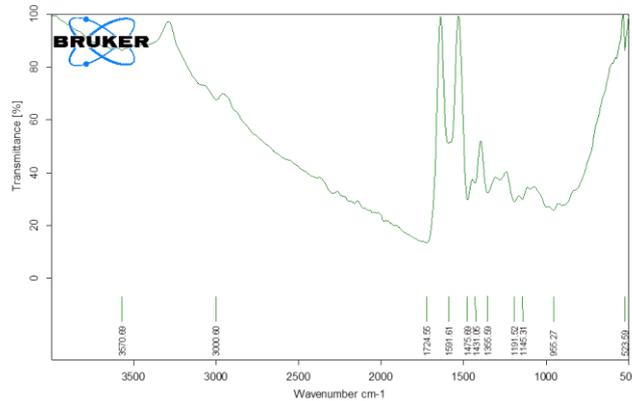


Fig 1: FTIR spectrum of human hair of 10 years dyed person.

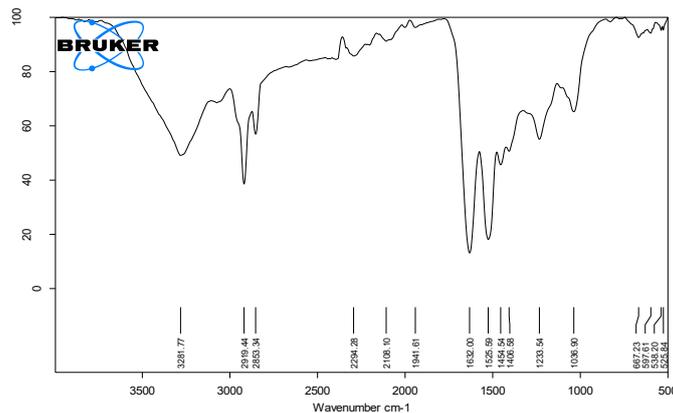


Fig 2: FTIR spectrum of human hair of 15years dyed person.

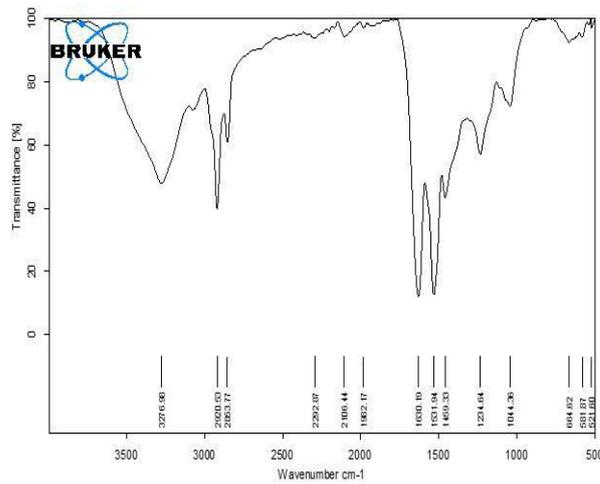


Fig 3: FTIR spectrum of human hair of twin A

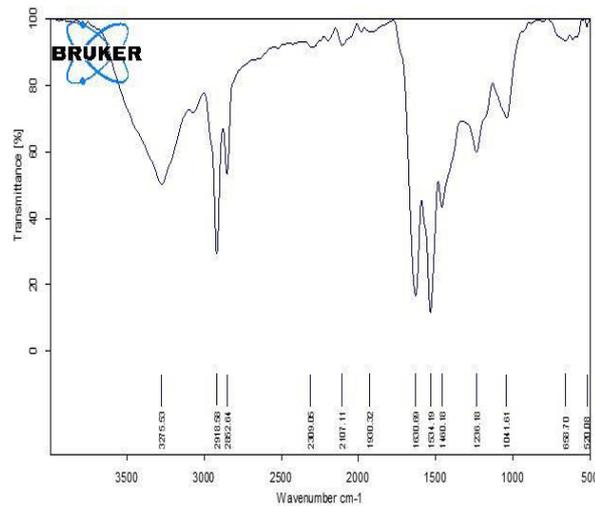


Fig 4: FTIR spectrum of human hair of twin B.

S.No	Wave number	Functional groups
	(Cm ⁻¹)	
1	523.59	C-Br Alkyl halide
2	955.27	O-H deformation ,Carboxylic acid
3	1145.31	C-O Alcohol
4	1191.52	C-N Amine
5	1355.59	-CO-CH ₃ (Ketones)
6	1431.05	C=C,-C=C-
7	1475.69	C=C Arene
8	1591.61	C=C Arene
9	1724.55	C=O Ester, Carboxylic acid, Aldehyde and Ketone
10	3000.6	C-H, CH ₂ , C=C Alkenes
11	3570.69	O-H Alcohol

Table 1: Band assignment for human hair of 10 years dyed person



S. No	Wave number (Cm ⁻¹)	Functional groups
1	525.84	C-Br Alkyl halide
2	538.2	C-Br Alkyl halide
3	597.61	C-Br Alkyl halide
4	667.23	NH ₂ and N-H wagging, O-H bending In-plane, CO ₂ (atmospheric absorption)
5	1036.9	C-O amide-I band, C-N, C-C, glucose
6	1233.54	P=O asymmetric stretching of PO-, phosphodiester 2
7	1406.58	C-F stret, -CF
8	1454.54	CH ₂ , CH ₃ asymmetric bending modes of lipids, proteins
9	1525.59	Amide II peak region – protein NH, (C-N), NO ₂ bond in nitro compounds, carboxylic acids and derivatives
10	1632	H-OH bending mode of water, NO ₂ bond in nitro compounds, Amide I band components β region pleated structures confirmation of proteins, C=C, C=N, (νC=C), NH ₃ in gas and vs
11	1941.61	C=C Arene
12	2108.1	C≡C Alkynes
13	2294.28	C≡C and C≡N stretching
14	2853.34	C-H symmetric stretching of CH ₂ in fatty acids, symmetric stretching vibrations of lipid acyl CH ₂ groups
15	2919.44	C-H symmetric stretching of CH ₂
16	3281.77	O-H carboxylic acids and derivatives, alcohols and phenols

Table 2: Band assignment for human hair of 15 years dyed person

S. No	Wave number (cm ⁻¹)	Functional groups
1	3276.98	C-H, CH ₂ , C=C alkenes
2	2920.53	C-H Symmetric stretching of CH ₂
3	2853.77	C-H Symmetric stretching of CH ₂ in fatty acids, vibration of liquid acyl CH ₂ group
4	2292.87	C≡N
5	2106.44	C≡C alkyne
6	1982.17	C=O (ketones, aldehydes, esters)
7	1630.19	C=C (alkene, aromatic ring)
8	1531.94	NO ₂ bond in nitro compounds
9	1459.33	C=O stretch
10	1234.64	C=O stretch
11	1044.36	C=O stretch
12	664.62	Cis-double bond(=CH)



13	581.87	Halogen compound(chloro-compound)[c-cl]
14	521.60	Halogen compound(chloro-compoud)[c-cl]

Table 3: Band assignment for twin A

S. No	Wave number(cm ⁻¹)	Functional groups
1	3275.53	C-H, CH ₂ , C=C alkenes
2	2918.58	C-H symmetric stretching of CH ₂
3	2852.64	C-H symmetric stretching of CH ₂ in fatty acids, vibration of lipids acylCH ₂ group
4	2309.05	C≡C alkynes
5	2107.11	C≡C alkynes
6	1930.32	C≡N
7	1630.69	C=C aromatic ring
8	1534.19	NO ₂ bond in nitro compound
9	1460.18	C=O stretch
10	1236.18	C=O stretch
11	1041.61	C=O stretch
12	658.70	Cis-double bond(=CH)
13	520.08	Halogen compound(chloro-compound)[c-cl]

Table 4: Band assignment for twin B

IV. CONCLUSION

The FTIR spectral differences from both 10 years dyed person and 15 years dyed person human hair samples were found. Twin A and Twin B hair samples were differentiated from their FTIR spectral analyses suggested that FTIR is a rapid, non-intensive and effective method in detecting their molecular and chemical changes.

REFERENCES

1. Barrow G M, Introduction to Molecular Spectroscopy, Mc Graw Hill, New York, 1962.
2. Baulsir C F & Simler R J, Advanced Drug Delivery Reviews, vol. 21, pp. 191-203, 1996.
3. Katon J E, Micron, vol.27, pp. 303-314, 1996.
4. Kokot S, Encyclopaedia of Materials: Science and Technology, 2001.
5. Feughelman M, Mechanical properties and structures of Alpha-Keratin Fibres, wool, Human and Related Fibres, University of New south wales press: Sydney, 1997.
6. Zviak C, The Science of Hair care, Marcel Dekker, Inc, 270 Madison Avenue, New York, 1986.
7. Creighton T E, Proteins: Structures and Molecular Properties; W.H.Freeman and company, New York, 1993.
8. Lyman D J & Wijelath J M, Fourier transform infrared attenuated total reflection analysis of human hair: comparison of hair from breast cancer patients with hair from healthy subjects, Appl. Spectroscopy, vol.59, pp. 26-32, 2005.
9. Johnson D H, Hair and Hair care, Marcel Dekker, Inc, New York, 1997.
10. Jachowicz J, Journal society cosmetic chemistry vol. 38, pp.263- 286, 1987.



11. Motz- Schalck L & Lemaire J, Journal of photochemistry and photobiology A : Chemistry vol.147, pp. 225-231, 2002.
12. Motz-Schalck L & Lemaire J, Journal of photochemistry and photobiology A : Chemistry vol.147, pp.233-239, 2002.
13. Carter H D, Twin similarities in occupational interests, Journal of Educational Psychology, vol. 23, pp. 641- 655, 1932.



**Impact Factor:
7.512**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details