THINK INDIA JOURNAL

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Spectroscopic analysis of Toys- A source of chronic poisoning

[1]Ms. Rajneet Kaur and [2]Ms. Harinder Kaur

[1] Student, Department of Forensic Science, School of Bio-engineering and Biosciences, Lovely Professional University, Phagwara, Punjab, India

[2] Assistant Professor, Department of Forensic Science, School of Bio-engineering and Biosciences, Lovely Professional University, Phagwara, Punjab, India

Corresponding Author: Ms. Harinder Kaur

Email ID- kaurharinderheer@gmail.com

Contact No.- +919530626972

Abstract

Toy obsession of infants indeed good for their cognitive development however, presence of cheap and harmful materials in toys is a constant worry. Recent studies have shown the presence of hazardous chemicals in toys. Infants licking habit could infest them with toxic substances of toys, which would be life endangering. In this regard, a study has been conducted on playthings to detect the presence of toxic substances such as phthalates and heavy metals by Fourier transform infrared (FTIR) and energy dispersive X-ray fluorescence (EDXRF) spectrophotometry. Four samples showed the presence of prohibited phthalates and of toxic heavy metals.

Keywords- Toys, Toxicity, EDXRF, Spectroscopy, Poisoning, Heavy metals

Introduction

Toys are the objects available in various shapes and size are used for playing by the children. Different toys like development sets and so forth play a significant role in physical as well as mental development of small

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

children. Toys are considered to perform different functions like to inspire, maintain child mentality and to help in companion gathering as some of games include shared play theme [1].

The toys are comprised of different materials like paper, wood, mud and can be sorted as follow –

- Construction sets-the isolated pieces are utilized to make some sort of model or to unravel some riddle.
- Dolls-a human model or creature model which is comprised of plastic, material piece, strands, wood etc.
- Teddy bears- made up of little filaments.
- Vehicles – minor duplicate or smaller than normal vehicles like truck, bicycle, bike, train, and so forth.
- Digital toys-like little robots, mechanical vehicles, little periodicals and so forth.
- Toys for physical action - incorporates football, cricket ball, ropes, and so on [2].

Plasticizers like DEHP (Di-Ethylhexyl Phthalate), DINP (Di-Isononyl Phthalate), and DINCH are the prohibited phthalates(Higgins 2013) which are used as the added to so that adaptability of the material can be increased and decline the strong intermolecular attractions so that chains can move openly and lessen the firmness of polymer [3].

Similarly, certain substantial metals like lead (Pb), cadmium (Cd), mercury (Hg), barium (Ba), arsenic (As), selenium (Se), chromium (Cr) are also added during assembling of plastic toys like a delicate duck to expand their adaptability and soundness [7]. Beside this, toys are covered with various paint layers to confer shading which may also contain heavy metals.

Toys as a source of poisoning

As the kids have propensity for mouthing and biting of toys which prompts introduction of these heavy metals inside the body and as rate of elimination of heavy metals is lower than the rate of their administration these get collected inside the body which leads to chronic poisoning. A number of cases have been reported about the toxicity from different toys. Lower sugar level in the blood whereas increased cholesterol level, change in kidney capacities, complications in the gastrointestinal tract, and malignant growth were the injurious impacts caused because of presence of toxic heavy metals in toys [7].

Material and Methods

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Sample Collection

Nine (9) toy samples were randomly collected from local markets of Jalandhar, Amritsar and Ludhiana areas of Punjab, India.

Table 1- Description of the collected samples

S.No.	Toys type	Colour of sample
1.	Jumping ball	Yellow
2.	Castle	Red and yellow
3.	Soft Duck	Blue
4.	Jumping ball	Greyish-yellow
5.	Castle	Yellow, pink and green
6.	Soft Duck	Orange
7.	Jumping ball	Pink and Yellow
8.	Castle	Red and yellow
9.	Soft Duck	Purple

Sample Preparation

Samples were fragmented to small pieces and crushed to powdered form by utilizing pestle and mortar and stored in transparent zipped bags for examination.

FTIR Spectroscopic Analysis

Samples were examined to check the presence of phthalates with special focus onto DOTP and DEHP by utilizing Shimadzu Fourier Transform Infrared Spectrophotometer. The samples were placed before IR radiation source and exposed for 12 numbers of scans for identification and analysis of samples.

EDXRF Spectroscopic Analysis -

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

To check the presence of heavy metals especially arsenic and lead in toy samples, Energy Dispersive X-ray beam brilliance spectrometer (Shimadzu) model no. EDX7000 was used. X-Ray beam cylinder was used as an excitation source. Samples were taken inside the test chamber and secured by Mylar sheet and exposed to radiation source for 5-7 minutes. Spectra were recorded with software named PCEDX.

Result and Discussion

Analysis by FTIR Spectroscopy

Nine samples were examined by utilizing FTIR to examine the presence of various phthalates like DOTP, DEHP, DOA, and DINCH which are presently restricted phthalates.

Sample no.5 shows the peak values at 611.45, 700.18, 742.62, 958.65, 1072.46, 1122.61, 1269.2, 1381.08, 1429.3, 1462.09, 1722.49, 2960.53, 2928.04 and 2958.9 (Figure 1). Peaks values between 1600-1500 for DOTP, 800-700 for DEHP, and 739.6 for DINCH phthalates were found using FTIR spectroscopy [4].

.

Sample no.6 shows the peak values at 538.16, 694.4, 752.26, 906.57, 1026.76, 1600.97, 1741.78, 2852.81, 2922.25 and 3026.41 (Figure 2). Peaks values between 1600-1500 for DOTP, 800-700 for DEHP, and 739.6 for DINCH phthalates were found using FTIR spectroscopy [4].

Sample no.8 shows peak values at 538.16, 694.4, 752.26, 1026.16, 1448.59, 1491.02, 1600.97, 1741.48, 1975.17, 2027.25, 2162.27, 2362.88 and 2922.25 (Figure 3). Peaks values between 1600-1500 for DOTP, 800-700 for DEHP, and 739.6 for DINCH phthalates were found using FTIR spectroscopy [4].

Sample no.9 shows the peak values at 609.53, 700.18, 742.62, 958.65, 1072.46, 1122.61, 1269.2, 1381.08, 1429.3, 1462.09, 1724.42, 2856.67 and 2924.18 (Figure 4). Peaks values between 1600-1500 for DOTP, 800-700 for DEHP, and 739.6 for DINCH phthalates were found using FTIR spectroscopy [4].

However, remaining five samples doesn't show the presence of DOTP, DEHP and DINCH by FTIR spectroscopy.

Analysis by EDXRF Spectroscopy

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Four samples (Sample no 5,6, 8 and 9) showed the presence of prohibited phthalates by FTIR so, further analysis of these four samples was performed by EDXRF to check the presence of heavy metals with special reference to lead and cadmium.

Sample no.5 showed the peak value between 12.5-13.0 eV for Lead (Pb), between 22.0-24.0 eV for Cadmium (Cd), at 12.0 eV for Bromine (Br) and between 2.0-3.0eV for Chlorine (Cl) (Figure 5). Hg, Pb, Cr, Cd and As were also examined in toys accessible in Sri Lankan markets by X-Ray spectroscopy [5].

Sample no.6 also showed the peak value between 12.5-13.0 eV for Lead (Pb), between 22.0-24.0 eV for Cadmium (Cd), at 12.0 eV for Bromine (Br), between 5.0-6.0 eV for Chromium (Cr) and between 2.0-3.0eV for Chlorine (Cl) (Figure 6). Hg, Pb, Cr, Cd and As were also examined in toys accessible in Sri Lankan markets by X-Ray spectroscopy[5].

Sample no.8 also showed the peak value between 12.5-13.0 eV for Lead (Pb), between 22.0-24.0 eV for Cadmium (Cd), at 12.0 eV for Bromine (Br), between 5.0-6.0 eV for Chromium (Cr) and between 2.0-3.0eV for Chlorine (Cl) (Figure 7). Hg, Pb, Cr, Cd and As were also examined in toys accessible in Sri Lankan markets by X-Ray spectroscopy [5].

Sample no.9 also showed the peak value between 12.5-13.0 eV for Lead (Pb), between 22.0-24.0 eV for Cadmium (Cd) and between 2.0-3.0eV for Chlorine (Cl) (Figure 8). Other metals were not detected in this sample.

China made PVC and non-PVC toys were also analyzed to examine the concentration of heavy metals and Pb (2.50-1445), Cd (0.50-373.33), Ni (31.17-119.67), Cu (12-93.67), Zn (266.67-2043.33), Cr (5-191.67), Co (1-73.33) and Mn (6.17-36.67) were detected by using atomic absorption technique [6].

Conclusion

Toys are commonly used by children for playing and various attractive toys are being introduced in the market which are made up of different materials like plastics, wood, rubber including phthalates and heavy metals so legitimate auditing of toys is required. A number of cases have also been reported in literature, which shows that exposure to different toys leads to health problems and death of children. A Forensic toxicologist has to give opinion about cause of poisoning. From present study, it has been concluded that presence of phthalates

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

and heavy metals in toys can become the source of chronic poisoning. FTIR and EDXRF techniques found to be suitable and accurate techniques with minimal sample.

References

[1] Trawick-Smith, "Effects of Toys on the Play Quality of Preschool Children: Influence of Gender, Ethnicity, and Socioeconomic Status" Early Childhood Education Journal, 43(4), 249-256, July 2015.

[2] S. Misra, "Toys and Safety regulations- centre for consumer studies", ISBN : 81-86641-83-1, Nov 2015

[3] Amato, B., Karl, S., & Ng, C. , "Phthalate plasticizers" , University of Buffalo, Buffalo, p CE435, April 2001.

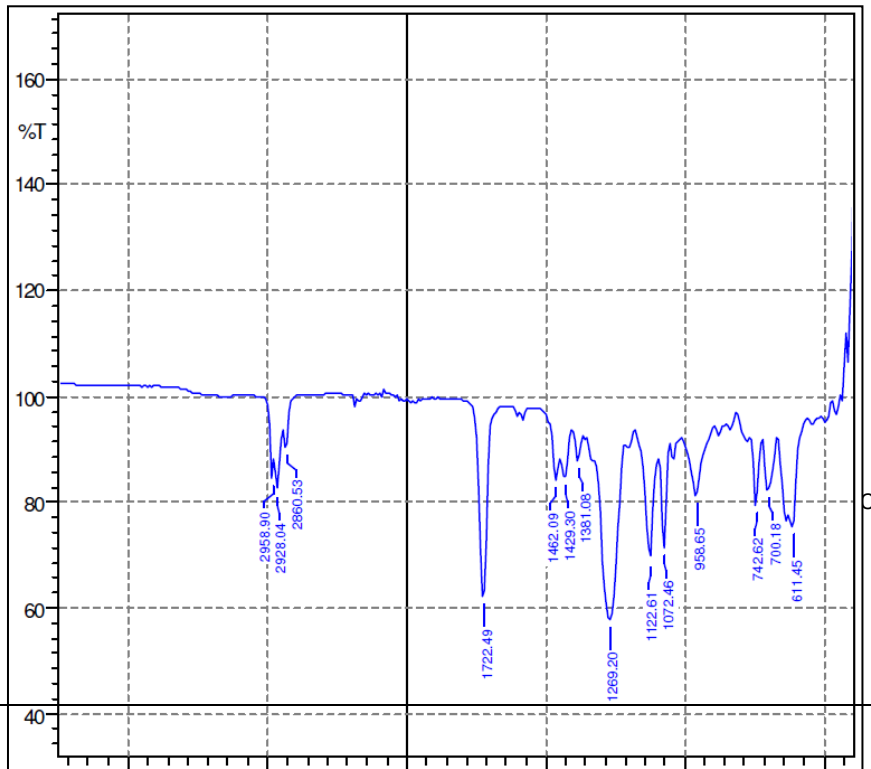
[4] Higgins F, "Rapid and reliable phthalate screening in plastics by portable FTIR spectroscopy". Agilent Technologies, Application Note, Publication no, 5991-3649, 2013.

[5] Ratnakumar, A., De Alwis, A. A. P., & Adikary, S. U. **, "** Investigation of the Presence of Heavy Metals in Plastic Toys Available in Sri Lankan Market" International Forestry and Environment Symposium, 22, 2017.

[6] J. A. Omolaoye, A. Uzairu and C. E. Gimba, "Heavy metal assessment of some soft plastic toys imported into Nigeria from China" , Journal of Environmental Chemistry and Ecotoxicology, 2(8), 126-130, October 2010.

[7] Chiedu, I. E., Akinyemib, M. I., Oyeyiolaa, A. O., Fatunsina, O. T., & Olayinkaaa, K. O. ," Statistical analyses and risk assessment of potentially toxic metals (PTMS) in children's toys" , Journal of Taibah University for Science, 11(6), 842-849, Nov 2017.

Figure 1: FTIR Spectrum of Sample No. 5.



ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Figure 2: FTIR Spectrum of Sample No. 6

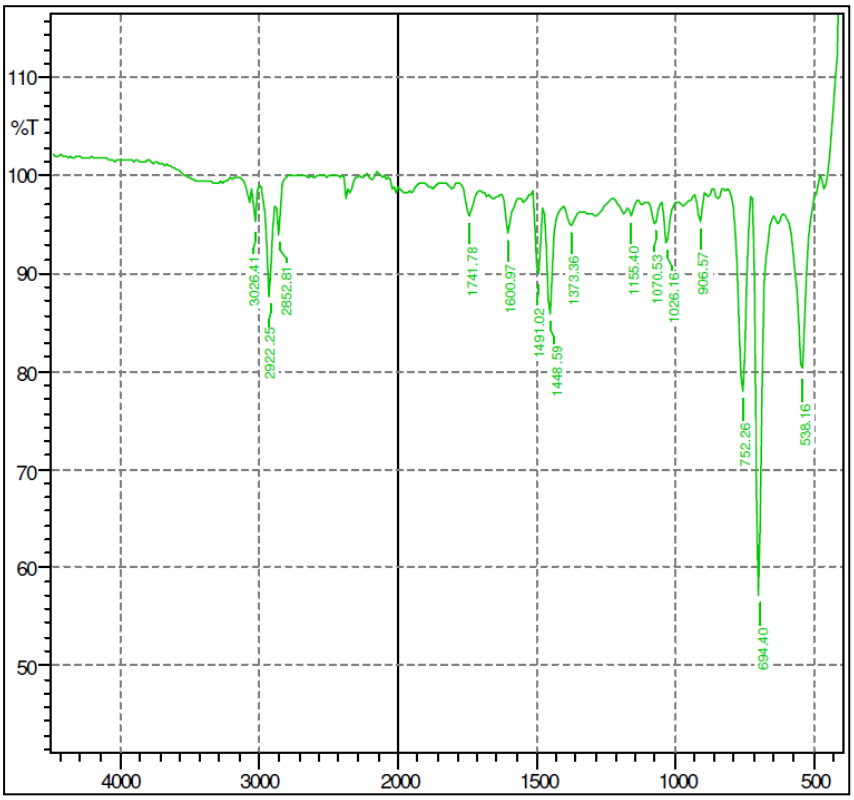
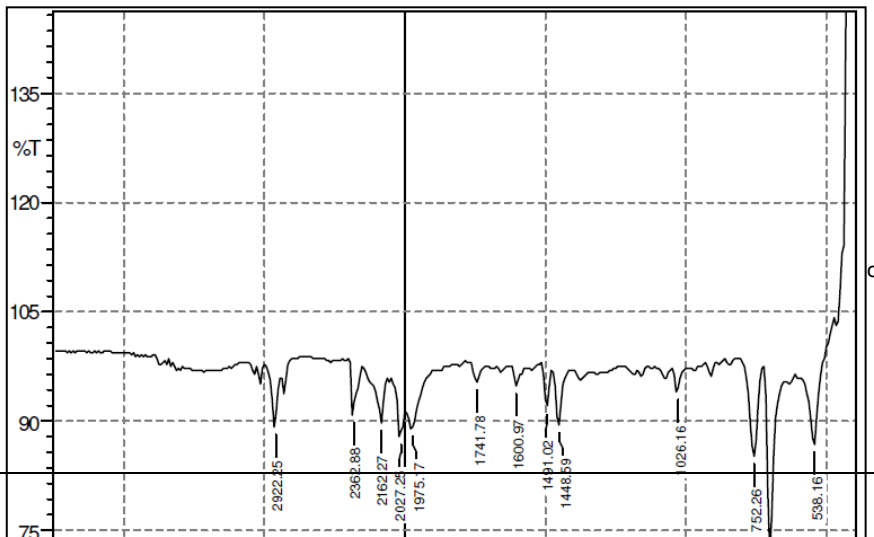


Figure 3: FTIR Spectrum of Sample No. 8



THINK INDIA JOURNAL

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Figure 4: FTIR Spectrum of Sample No. 9

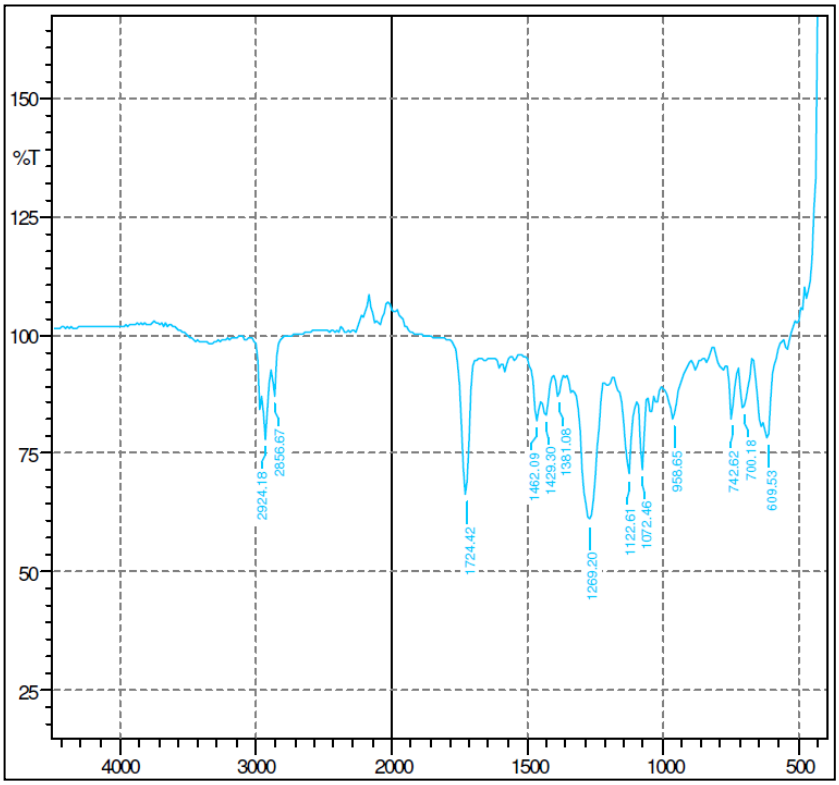
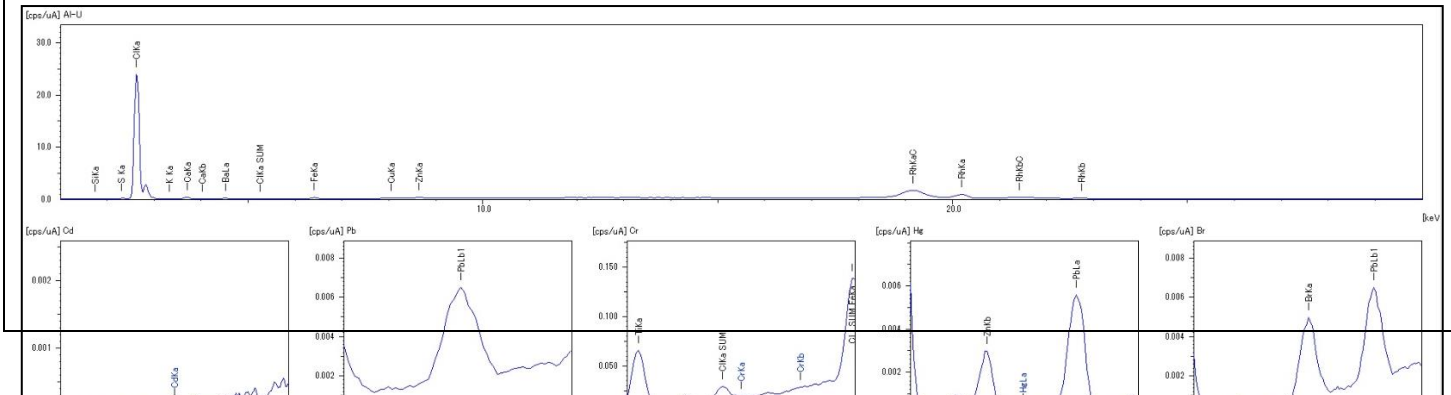


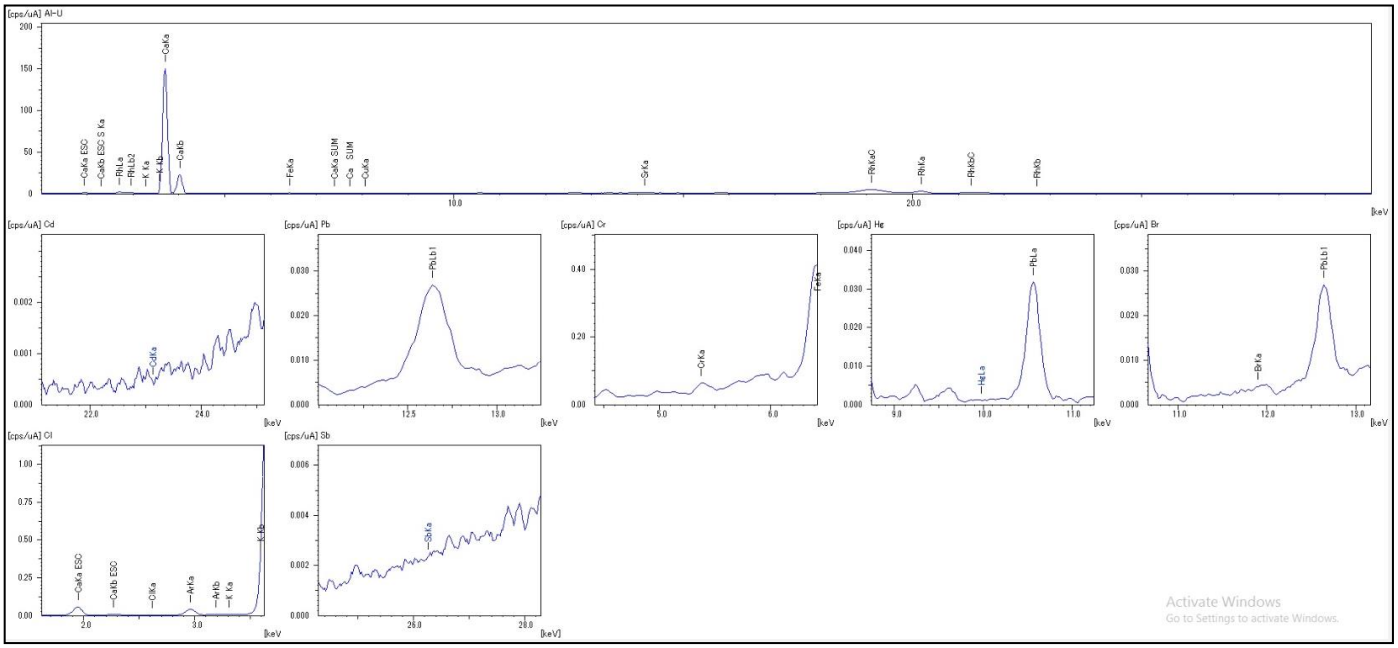
Figure 5: EDXRF Spectrum of Sample No. 5



ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Figure 6: EDXRF Spectrum for Sample No. 6



THINK INDIA JOURNAL

ISSN: 0971-1260

Vol-22-Issue-17-September-2019

Figure 7: EDXRF Spectrum of Sample No. 8

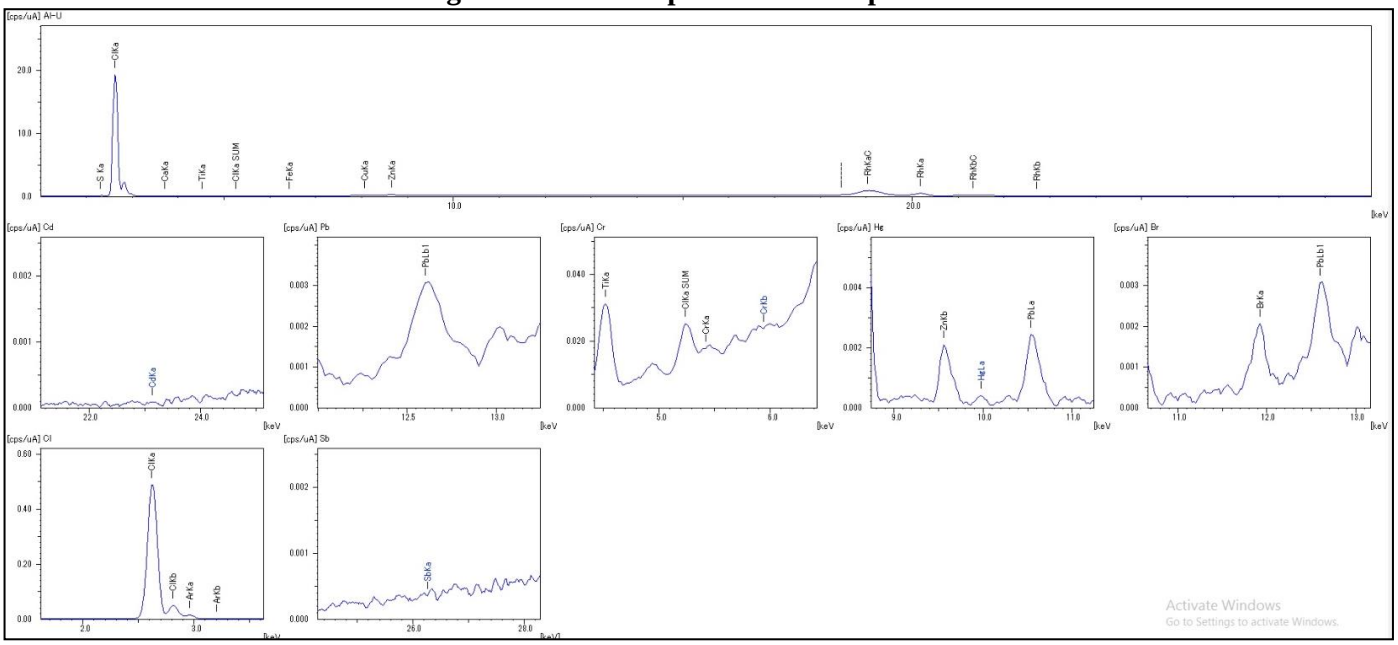


Figure 8: EDXRF Spectrum of Sample No. 9