Power System Technology
Volume49, No.3, 2025
ISSN:1000-3673

Physicochemical Study of Some Pollutants Deposited on a Glass Slide

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Abstract

In the context of diagnosing some air pollutants, we conducted a physiochemical study of a glass slide that was used as a surface for interaction and deposition for a period of 11 months in the reading room of the Library of the Faculty of Mathematics and Matter Sciences at the University of Kasdi Merbah in Ouargla. This study was carried out using some spectroscopic techniques: Uv-Vis, FTIR, and XRF fluorescence, where the results showed the opacity of the glass sample as well as the deposition of both alcoholic and amino compounds on it through molecular bonds and specific functional groups. The results also showed the deposition of several new chemical elements resulting from dust.

Key Words: Pollution, Atmosphere, Chemical Bonding, Analytical Techniques.

1. Introduction

Planet Earth is currently witnessing rapid climatic and environmental changes that have attracted the interest of scientists and specialists in various fields, most notably the study of the atmosphere. The atmosphere is not limited to being a medium in which living organisms breathe, but rather it is a complex dynamic system that is affected and interacts with many factors.

Air pollution is one of the most serious environmental and health issues of our time, affecting the global climate and increasing the risk of chronic diseases such as asthma and cardiovascular disease. It also has a negative impact on biodiversity and ecosystems. The problem is particularly acute in urban areas, where populations are growing and industrial activities continue to expand.

Air pollution is the introduction of harmful or polluting substances into the atmosphere, affecting air quality and harming the overall health of humans and living organisms. Air pollution includes a range of pollutants that may be natural or man-made, such as toxic gases (carbon dioxide, sulfur dioxide, nitrogen oxides), fine particulate matter (PM2.5 and PM10), and toxic chemicals such as volatile organic compounds. Air pollution can result from many human activities, such as industry, transportation, combustion, and urban expansion.

Studies indicate that air pollution is a major cause of premature death, making addressing this problem crucial to protecting human health and the environment.

Air pollution remains one of the most critical environmental challenges of the 21st century, with significant consequences for public health, ecosystems, and the global climate. The World Health Organization (WHO) estimates that ambient air pollution is responsible for approximately 4.2 million premature deaths annually and that global life expectancy is reduced by about two years[1], primarily due to cardiovascular diseases, respiratory infections, lung cancer, and other chronic conditions [2-3-4-5]. This global health burden highlights the urgency of scientific efforts to understand, monitor, and mitigate air pollution [6]. Among the various disciplines helping to mitigate this challenge, analytical chemistry stands out as a key player, providing precise tools for the detection, identification, and quantification of atmospheric pollutants [7-8].

The monitoring of our atmosphere is a vital component of analytical chemistry, on the basisof the fact that air quality has a direct impact on the environment and human health. Air pollution has been shown to be involved in numerous pathologies, typically cardiovascular and respiratory based, but also links to reproductive function have been made[9]. Many impacts of air pollution are complex and result from the chemical and physical interactions of a number of atmospheric species from a plethora of sources[10-11]. A recent review, for example, explored the interplay of air pollution, food production, and food security, where food production incurs air pollution which in turn negatively impacts food security. Patricia Forbes The measurement and distribution of total suspended particles (TSP) in the urban environment of Setif were studied, and the impact of surrounding industrial activities was analyzed. It was confirmed that the industrial area adjacent to Setif is a significant source of air pollution. Pollution is concentrated during certain periods of the year and is intertwined with industrial activity and atmospheric changes affecting atmospheric stability [12].

The study of the atmosphere in the modern era has become an urgent necessity, especially with the increase in phenomena such as global warming, climate change, air pollution, and the hole in the ozone layer. This study includes understanding the components of the atmosphere, the distribution of gases, and the physical and chemical processes that occur in it. The physicochemical study of air pollution falls within a branch of chemistry that combines physical and chemical principles to analyze the behavior and interactions of materials in the atmosphere. This study aims to understand the nature of gaseous and particulate pollutants, the ways they interact with the components of the air, and the factors that affect their dispersion, disintegration, or accumulation, such as temperature, pressure, and sunlight.In addition to the impact of human activity such as industrial emissions and the burning of fossil fuels[13-14-15].

Pollution in the atmosphere is analyzed using techniques like spectroscopy (e.g., atomic absorption, IR, UV-Vis) and chromatography (e.g., gas, liquid), often combined with mass spectrometry. These methods help identify and quantify pollutants by separating and detecting them based on their chemical bonding properties. Atmospheric chemistry is crucial, as chemical reactions in the atmosphere, including those involving radicals, both create and remove pollutants.

2. Exprementational

2.1. Sample Preparation

Here, we will outline the various steps involved, starting with hanging the sample.

Preparing the studied sample:

The piece of glass was hung in the reading room of the library of the Faculty of Mathematics and Materials Sciences at Kasdi Merbah University, Ouargla, on January 16, 2019. We then removed it on November 26, 2019, ensuring that its front surface was preserved, which we would use to conduct various spectroscopic analyses.

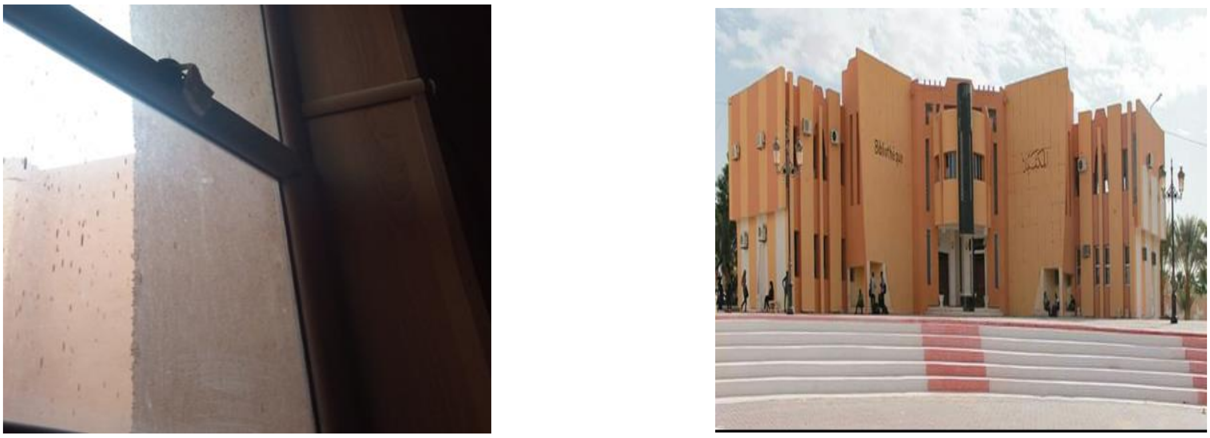


Figure 1.Location and place of the studied sample

Preparing the control sample:

We prepared the control sample and washed it in the chemistry lab with a dichloromethane solution, then with water, to ensure proper cleaning and preserve its front surface for comparison with the suspended sample studied.

Figure .2.Preparing the control sample

Spectroscopic analysis methods:

Study of the suspended and control samples using an ultraviolet-visible spectrophotometer:

We first place the suspended sample in the device and then record the given results. Then we remove the suspended sample and place the control sample in the device and also record the given results.

Figure.3.UV-Vis Spectroscopy

Studying the suspended and control samples for measurement using an infrared device:

We first place the suspended sample in the device and then record the results. We then remove the suspended sample and place the control sample in the device, also recording the results.

Figure .4. Fourier transform infrared absorption spectroscopy.

Studying the suspended and control samples for measurement using X-ray fluorescence:

Place the suspended sample on the fluorescence device holder, then shine the device directly onto it. Press the device button to emit X-rays and obtain its compounds.

Figure .5.X-ray fluorescence device

3. Results and discussion

UV-Vis Spectroscopy Results:

For qualitative analysis of the sample, it is sufficient to know the absorption wavelengths present on the sample surface.

The figure below shows that the UV-Vis results for both samples are almost identical, with no distinct absorption wavelength.

For reference, we note a slight decrease in absorption intensity over the range (337-575). This is most likely due to the somewhat opaque nature of the suspended sample resulting from some sedimentation.

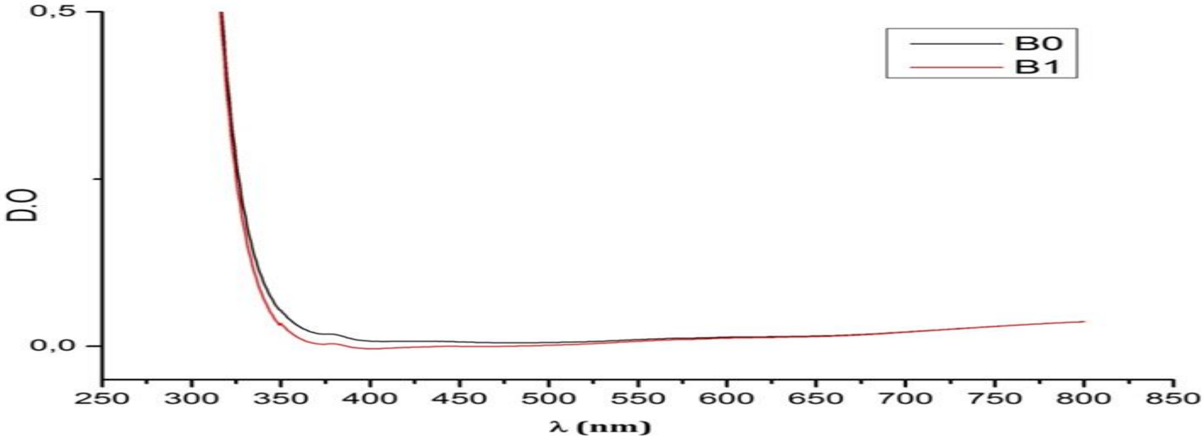
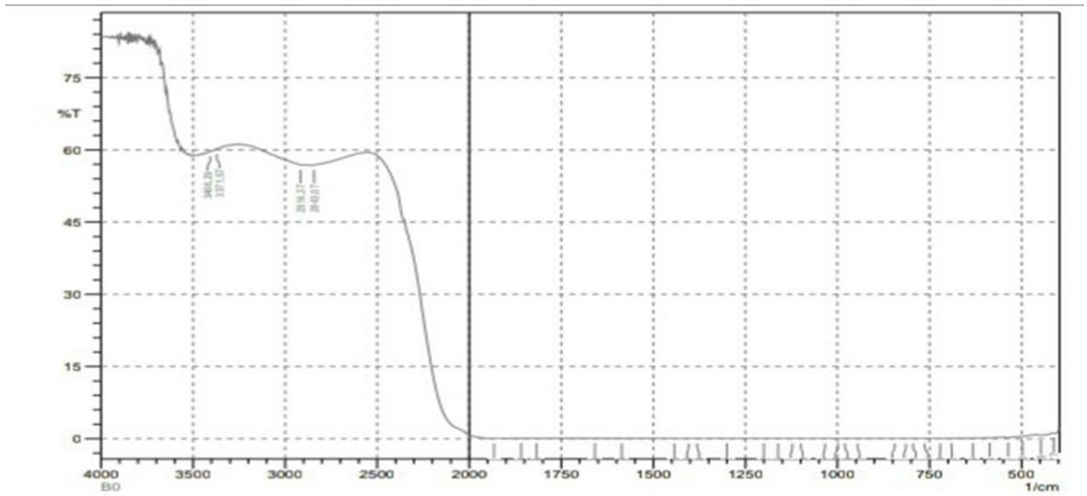


Figure .6. UV-Vis absorption spectra of the two samples,B0 is The witness sample ,B1 is Pending sample

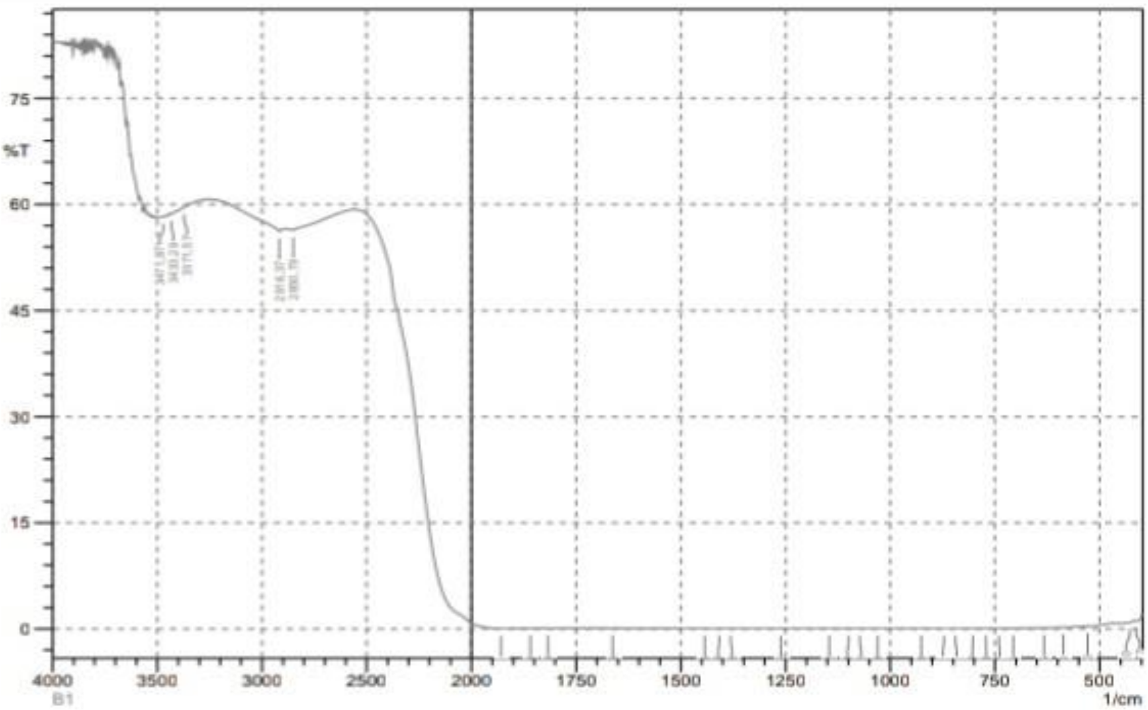
Infrared Spectroscopy Analysis Results:

For qualitative analysis and comparison between the two samples, it is sufficient to know the absorption wavelengths of the chemical groups present on the surface. This is done using infrared spectroscopy for the control and suspended samples. The two curves illustrating transmittance as a function of wavenumber using infrared spectroscopy are shown in Figures 5 and 6 below.



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	412,77	1,098	0,243	416,62	397,34	36,113	1,775
2	447,49	0,681	0,204	455,2	420,48	72,658	2,808
3	497,63	0,442	0,058	501,49	470,63	68,379	0,449
4	536,21	0,171	0,16	543,93	505,35	95,711	2,303
5	586,36	0,164	0,029	594,08	547,78	122,429	0,797
6	632,65	0,115	0,009	636,51	597,93	110,136	0,756
7	690,52	0,062	0,007	694,37	667,37	82,606	0,19
8	721,38	0,048	0,003	725,23	702,09	75,692	0,394
9	763,81	0,03	0,005	767,67	748,38	66,864	0,889
10	794,67	0,019	0,007	802,39	771,53	111,184	1,203
11	813,96	0,01	0,011	821,68	802,39	73,844	3,134
12	844,82	0,008	0,006	852,54	829,39	91,627	3,574
13	945,12	0,021	0,002	964,41	937,4	98,517	0,639
14	979,84	0,021	0,005	987,55	968,27	69,899	0,77
15	999,13	0,018	0,006	1010,7	991,41	71,027	1,267
16	1033,85	0,02	0,006	1045,42	1014,56	112,741	1,8
17	1099,43	0,022	0,005	1111	1083,99	97,302	1,269
18	1122,57	0,007	0,017	1149,57	1114,86	130,92	4,767
19	1161,15	0,018	0,003	1172,72	1153,43	71,656	0,673
20	1199,72	0,019	0,001	1211,3	1192,01	71,612	0,345
21	1300,02	0,025	0,001	1311,59	1292,31	69,39	0,252
22	1381,03	0,035	0,005	1392,61	1373,32	66,134	0,587
23	1404,18	0,037	0,005	1415,75	1396,46	65,865	0,728
24	1442,75	0,034	0,011	1454,33	1435,04	65,908	1,343
25	1585,49	0,05	0,015	1616,35	1573,91	138,028	3,14
26	1658,78	0,074	0,029	1670,35	1651,07	59,148	1,467
27	1816,94	0,078	0,009	1824,66	1793,8	95,211	0,835
28	1859,38	0,073	0,012	1867,09	1843,95	71,922	1,018
29	1932,67	0,008	5,5	2546,04	1870,95	830,238	39,398
30	2843,07	56,824	0,037	2846,93	2565,33	66,307	0,118
31	2916,37	56,867	0,183	3005,1	2904,8	24,218	0,089
32	3371,57	60,149	0,065	3375,43	3317,56	12,608	0,008
33	3406,29	59,604	0,062	3410,15	3375,43	7,726	0,005

Figure .7. Infrared absorption spectrum of the control sample



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	412,77	1,089	0,271	416,62	397,34	35,826	1,631
2	428,2	0,84	0,099	432,05	420,48	23,261	0,25
3	528,5	0,364	0,072	536,21	470,63	150,056	3,459
4	586,36	0,188	0,02	590,22	551,64	101,155	1,295
5	632,65	0,118	0,026	644,22	594,08	142,416	2,347
6	705,95	0,061	0,012	713,66	667,37	142,448	1,619
7	740,67	0,043	0,003	744,52	713,66	101,657	0,695
8	771,53	0,027	0,005	779,24	752,24	93,542	0,576
9	802,39	0,018	0,004	806,25	783,1	83,907	0,876
10	844,82	0,004	0,005	848,68	837,11	47,845	2,223
11	871,82	0,006	0,003	875,68	864,11	48,017	0,872
12	925,83	0,014	0,004	941,26	918,12	88,063	1,466
13	1029,99	0,015	0,006	1041,56	1018,41	87,068	1,968
14	1072,42	0,016	0,006	1083,99	1064,71	72,137	1,595
15	1099,43	0,019	0,003	1111	1087,85	85,606	0,923
16	1145,72	0,017	0,003	1149,57	1134,14	57,543	0,607
17	1261,45	0,021	0,001	1265,3	1246,02	70,451	0,232
18	1381,03	0,035	0,003	1392,61	1365,6	92,705	0,49
19	1408,04	0,035	0,005	1415,75	1396,46	66,422	0,666
20	1442,75	0,033	0,008	1454,33	1435,04	66,419	1,168
21	1662,64	0,068	0,024	1670,35	1651,07	59,751	1,552
22	1816,94	0,075	0,009	1824,66	1793,8	95,743	0,99
23	1859,38	0,072	0,009	1867,09	1843,95	72,265	0,834
24	1928,82	0,008	5,139	2546,04	1870,95	830,605	37,775
25	2850,79	56,35	0,456	2881,65	2565,33	75,404	0,43
26	2916,37	56,162	0,669	3005,1	2889,37	28,357	0,215
27	3371,57	59,598	0,07	3375,43	3317,56	12,822	0,009
28	3433,29	58,643	0,099	3437,15	3375,43	14,088	0,025
29	3471,87	58,266	0,071	3475,73	3456,44	4,513	0,008

Figure .8. Infrared absorption spectrum of the suspended sample.

The comparison aims to detect additional functional groups, which represent the formation and precipitation of new chemical compounds not previously present in the original control sample.

The comparison revealed the presence of a new functional group at wavenumber 3471.87, located in one of the following two ranges:

• (3500-3410) for the primary amino group, which expresses the presence of the (N-H) bond, and thus this indicates the deposition of protein compounds of human origin, given the presence of the studied sample in the reading hall.

• (3600-3300) for the alcohol group, which represents the presence of the (C-OH) bond. This indicates the precipitation of alcoholic compounds. This is very likely given the frequent use of perfumes containing alcohol, in addition to the use of cleaning materials by cleaners, which often also contain alcoholic substances.

Therefore, the presence of both of these compounds in the sample studied is very likely and logical.

X-ray fluorescence analysis results:

The analysis results shown in Tables 1 and 2 show the percentages of chemical elements present in the studied suspended and control samples.

Table1.XRF analysis results of the control sample.

Vehicles	Percentage of Vehicles
Mg	19. 48%
Si	75. 32%
Fe	2.89%
Cr	0.78%
Mn	<LOD
Ni	0.86%
Zr	1.36%

Table 2. Results of analysis of the studied sample suspended by fluorescenceXRF.

Vehicles	Percentage of Vehicles
Mg	18. 94%
Si	74. 44%
S	0.34%
Cr	0.74%
Mn	0.25%
Fe	2.70%
Ni	0.71%
Zn	0.05%
Zr	1.47%

Comparison of the results of the two samples:

We note that the two samples contain different proportions of compounds, with these compounds present in high and low proportions. They also contain common elements, such as Mg, Si, Fe, Ni, Zr, and Cr. These common elements contribute to the basic composition of the sample, which represents glass. We also note the appearance of new chemical elements in the suspended sample studied, namely (S, Mn, and Zn).

Upon closer examination of the ratios, we also note an increase in the presence of (Zr).

The presence of these elements in the suspended sample can be explained by the possibility that they accumulated in the chamber throughout the suspension period. It is also possible that their source is dust or cosmetics containing these elements.

4. Conclusion

In this work, we studied the interaction of a glass surface with air by suspending a piece of glass for 11 months in the reading room of the library of the Faculty of Mathematics and Materials Sciences at KasdiMerbah University, Ouargla. The aim was to identify the compounds present in the atmosphere of this room during that period. This study was conducted using spectroscopic techniques: ultraviolet-visible (UV-Vis), infrared (FTIR), and X-ray fluorescence (XRF). The UV-visible absorption spectroscopy technique determined

the intensity of light absorption, revealing the opacity of the suspended sample compared to the original control sample. The results of the infrared absorption spectroscopy enabled us to detect the presence of alcoholic and protein compounds in the suspended sample through molecular bonds and specific functional groups. The X-ray fluorescence technique provides the concentrations of atomic elements present in the sample, revealing several elements deposited on the suspended sample.

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