A STUDY ON DETERMINING MICROPLASTICS IN AMBIENT AIR QUALITY OF METRO MANILA

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April 2025

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INTRODUCTION

Microplastics (MPs) have emerged as a pervasive environmental issue with profound implications for air quality and public health. These small plastic particles, classified into primary and secondary types, are increasingly detected in atmospheric environments, underscoring its ubiquitous presence. Metro Manila, the densely populated capital region of the Philippines, presents an ideal study area for analysing MPs impacts on ambient air quality. With its rapid urbanization, extensive road networks, and high vehicular emissions, Metro Manila exemplifies urban settings where MPs are prevalent. This study aims to characterize the presence of MPs in the ambient air, explore the sources and physical behavior, and assess the potential health risks, if any.

REVIEW OF RELATED LITERATURE

Existing studies provide a comprehensive understanding of microplastics' characteristics, transport behaviors, and health impacts. Key finding include:

Characteristics and Transport: Studies such as meta-analysis by Fox et al., (2024) highlighted the correlation between MPs' physical traits (e.g., polymer type, color, shape) and their atmospheric transport. Fibrous MPs are particularly significant due to their slow settling velocity and ability to reach higher altitudes as explored by Tatsii et al. (2024). Jiang et al. (2024) examined MPs' residence time, emphasizing their aggregation potential and interaction with other airborne particles.

Sampling and Detection Methods: Researchers, including Wright et al. (2021) and Chen et al. (2020) emphasized standardized criteria and analytical methods for assessing MPs in air, covering techniques like Fourier-transform infrared (FTIR) spectroscopy and Raman microscopy. Active and passive sampling approaches are utilized globally.

Health impacts: Studies such as those by Li et al. (2023) and Lee et al. (2023), documented the adverse effects of MP exposure on the digestive, respiratory, endocrine and immune systems. MPs presence in human environments, including food, air, and daily-use products, underscores their multifaceted risks.

These findings provide a robust foundation for studying MPs in Metro Manila's ambient air quality.

METHODOLOGY

This study utilized the filters that are sampled using a regulatory-grade high volume sampler at various locations in the National Capital Region (Figure 1).

Figure 1: Sampling sites of High Volume Sampling for TSP in the National Capital Region for 2016-2022.

1. Laboratory preparation, sample registration and collection of MPs from Total suspended Particulate Matter samples

The filter samples were transported at the DMGC lab in Taytay, Rizal for processing of microplastics. A workspace, free of dusts and equipped with ventilation and laminar flow hood was designated for the collection of microplastics. The laboratory workspace was sterilized using ethanol to prevent sample contamination. Aluminum foil was used to cover the working surfaces, minimizing external microplastic interference. Lint remover were rolled over the laboratory gown of the analyst prior to entering the laboratory. Instruments including tweezers, glass slides and coverslips were sanitized with 70% isopropyl alcohol before use. Digital and compound microscopes were calibrated and readied for analysis.

Two hundred forty seven (247) filters sampled using High Volume sampling techniques for Total Suspended Particulate Matter (TSP) gathered between 2016 to 2022 in the National Capital Region were used in the initial screening of microplastics in the air of Metro Manila.

Sub-sampling was done by punching a portion of the sampled TSP filters with a stainless-steel puncher with a diameter of 45 millimeter. Each portion of the filter samples were carefully registered, coded and stored in a labeled sample container to ensure traceability. This subsample was then subjected to microscopy, with the objective of screening and nitpicking any suspected microplastics. The suspected microplastics are then collected using stainless steel forceps and kept in a glass scintillation vial until detection.

Microscopic examination was done in two ways: using digital microscopy and using compound microscopy. Using a digital microscope, air filter samples were observed, suspected MPs were visually identified, photographed and assigned sample IDs. Suspected MPs underwent detailed analysis at varying magnifications to examine their size, shape, texture and other physical characteristics. Observations were documented.

Figure 2: Materials used for the collection of suspected MPs

2. Detection and identification using Fourier-Transform infrared spectroscopy

Polymer composition of suspected MPs was confirmed to ensure accurate identification. The confirmation was done using the Fourier-Transform Infrared (FTIR) Spectrometer. It is a non-destructive analytical instrument used to obtain infrared spectrum based on the amount of absorption or transmittance of infrared in a sample. In this study, the mid infrared region (40000 cm-1 - 400 cm-1) was used to detect and identify the suspected MPs, and is divided into a two steps: first, detection of the functional group (400 to 1500 cm-1), followed by the identification of the fingerprint region (1500 to 400 cm-1). In theory, no two compounds have the same fingerprint region in the infrared spectrum. The two-step identification is made possible by matching the spectrum of the sample with the spectra of the standards in the built-in library of the IRSpirit of Shimadzu ® with an ATR accessory and over 1,500 default library for inorganic, organic, polymer, agrichemicals, pharmaceuticals and reagents.

PRELIMINARY RESULTS

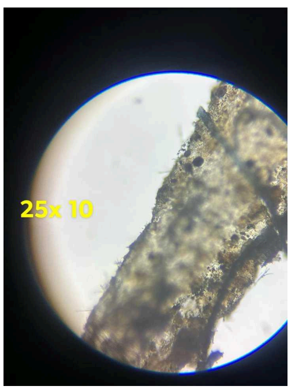
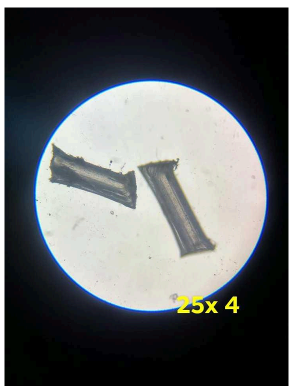
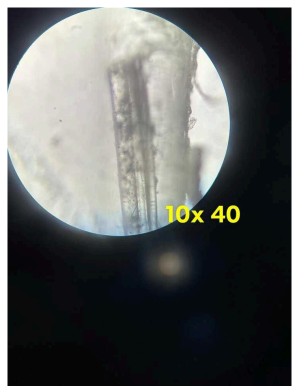
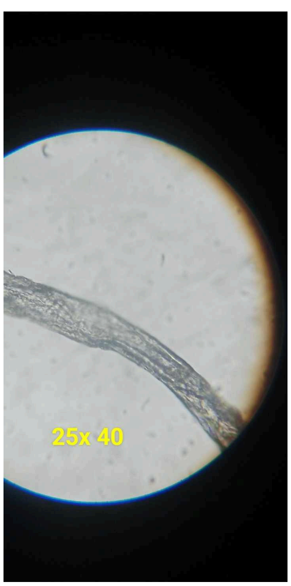
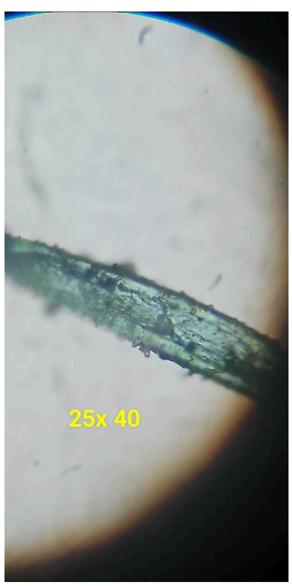
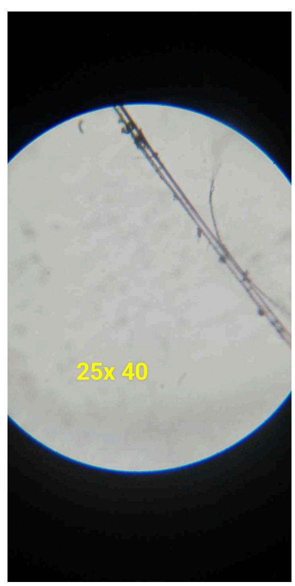
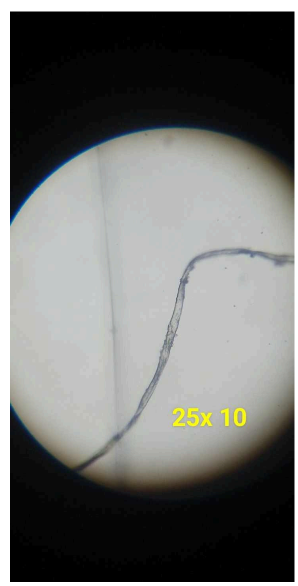
National Capital Region Sites studied

As of the date, the NCR sites with TSP sampled that are used in this study are the following:

1. Manila
2. Valenzuela
3. Marikina
4. Quezon City
5. Makati

Collected Suspected Microplastics In Air Particulate Matter:

Out of the 247 samples, thirty one (31) were collected as suspected microplastics. Most of the detected and collected suspected MPs are rod-shaped. These are shown in the figures below:

 25000016	 25000019	 25000033	 25000072
			

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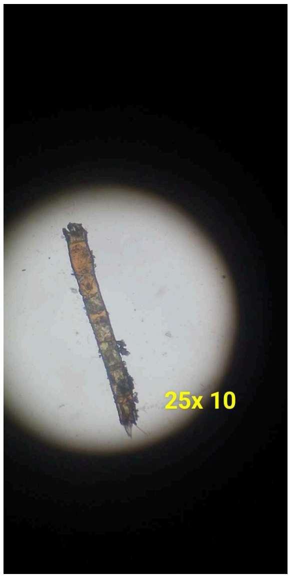
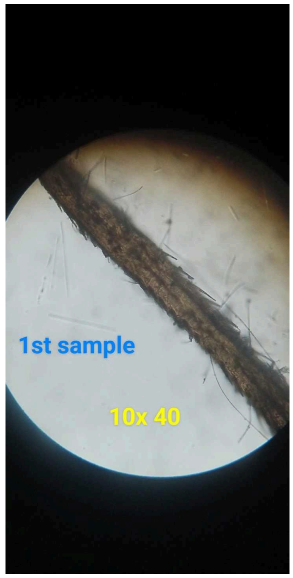
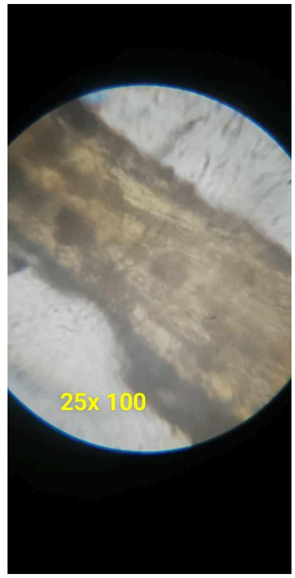
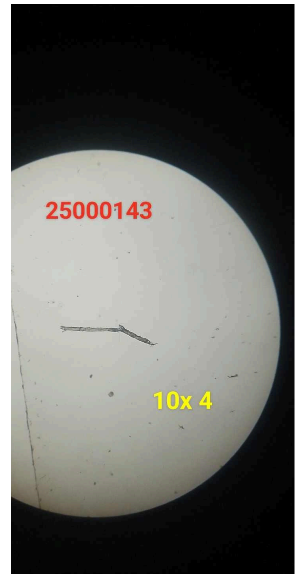
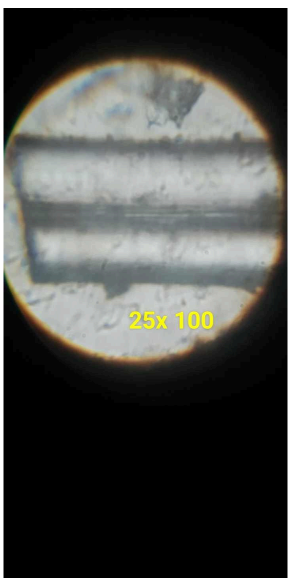
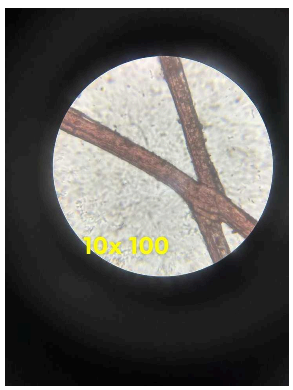
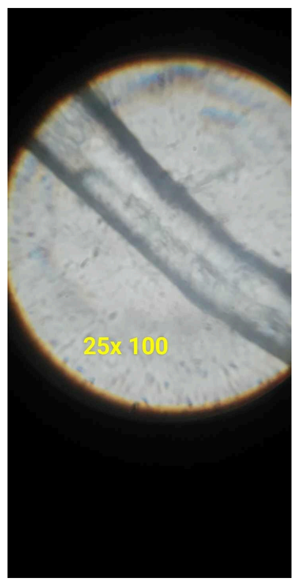
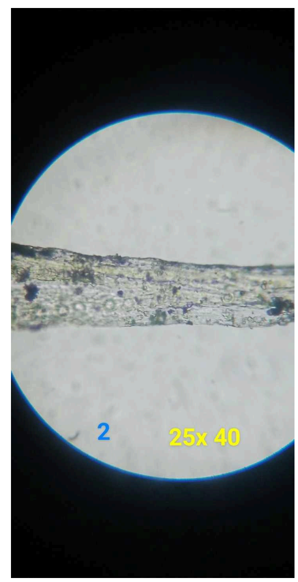
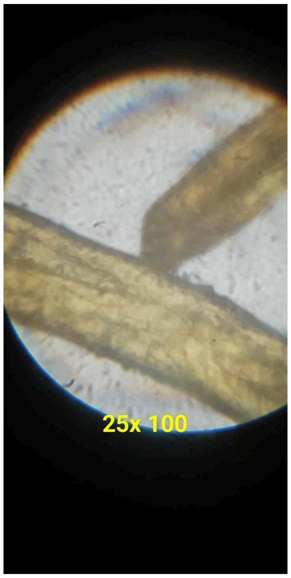
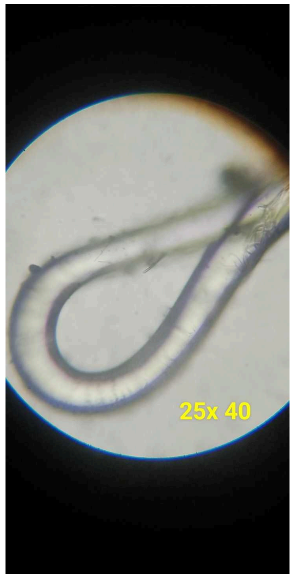
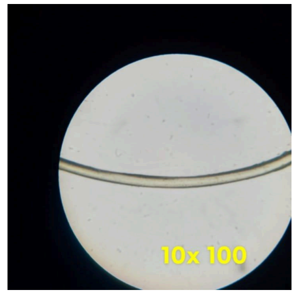
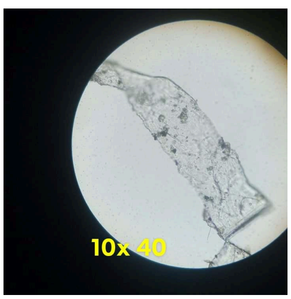
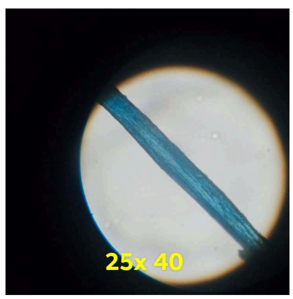
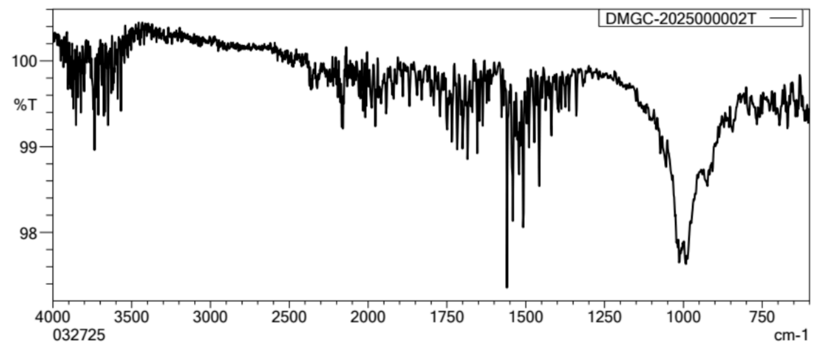
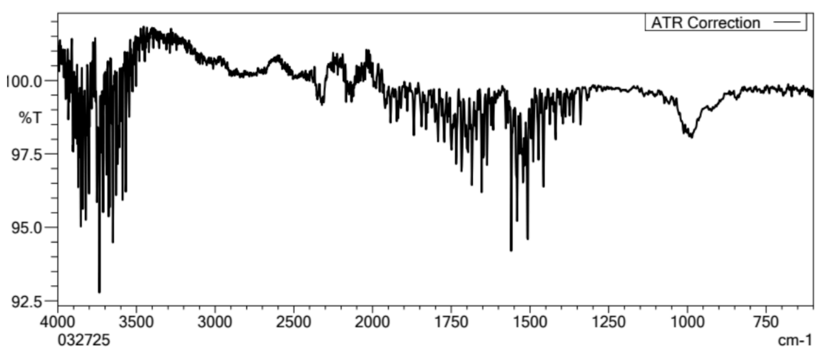
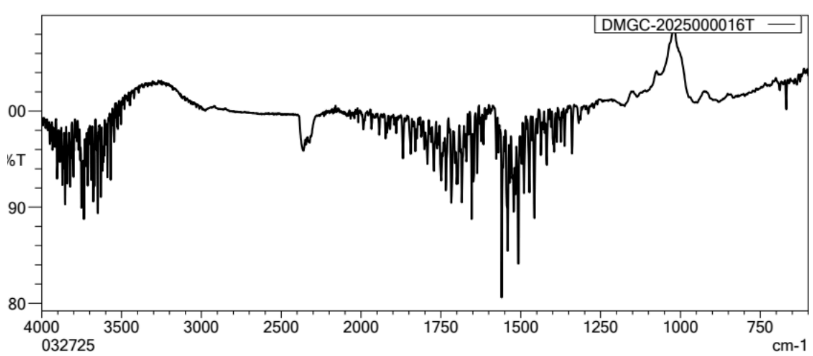
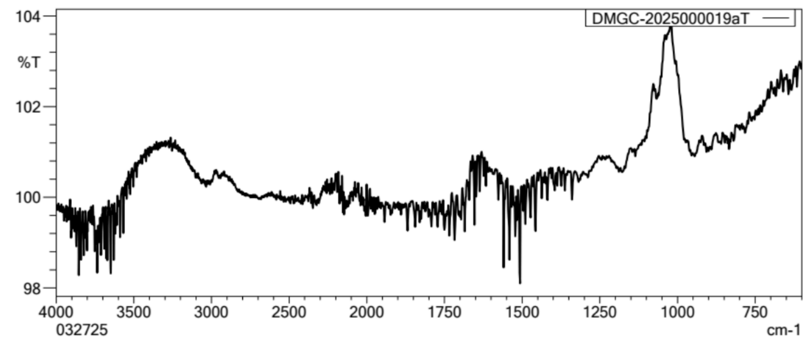
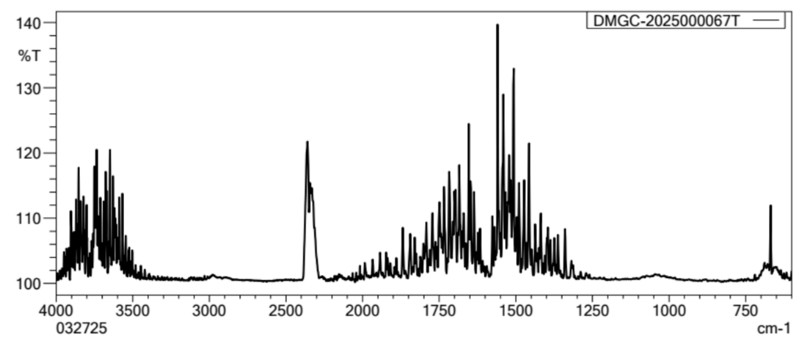
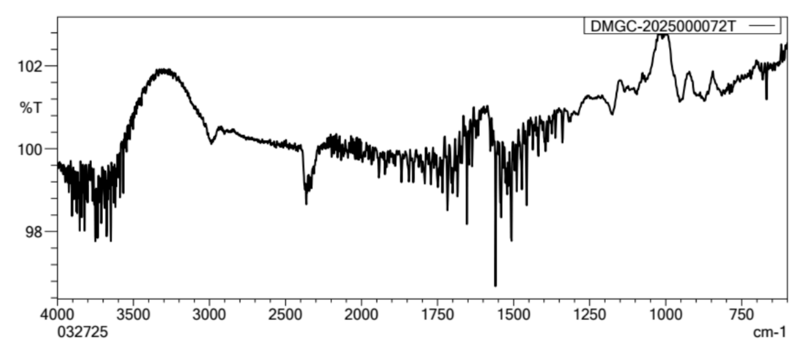
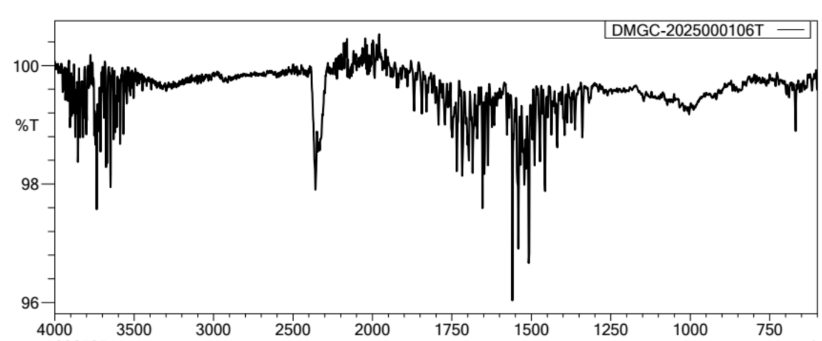
 25000128	 25000130	 25000131	 25000143
 25000149	 25000159	 25000167	 25000168

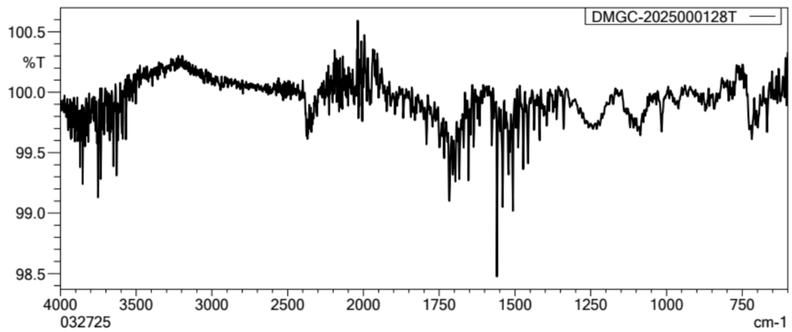
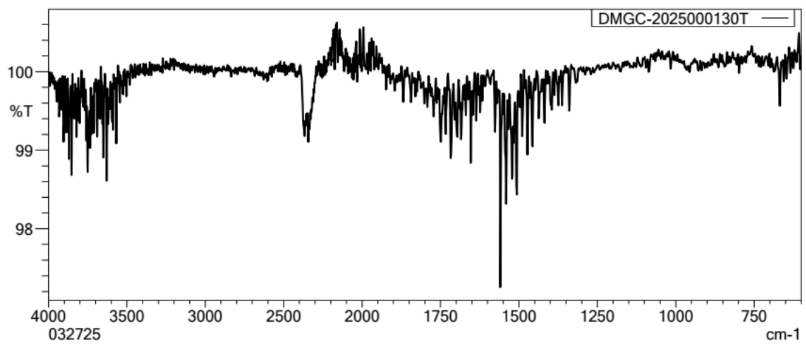
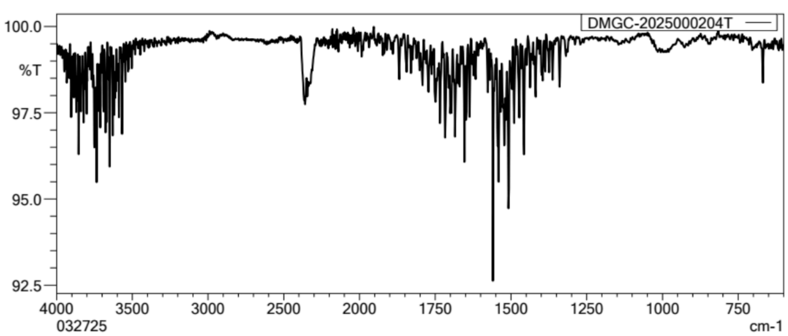
 25000186	 25000188	 25000200a	 25000200b
 25000204	 25000215	25000002  Eyepiece: 25x Objective: 20x	 25000003

Detected And Identified Microplastics In Air Particulate Matter

The plot of the infrared spectrum, as well as the identification based on the built-in library is presented in the figures below. The identified microplastics are cellulose, cellophane, polyvinyl, Tencel, HDPE and Rayon, with confidence ranging from 51% to 64%.

Plot	Confidence/ID
 25000002	61% ATR-Polymer-Cellulose 61% ATR-Polymer- Tencel
 25000003	56% ATR-Polymer-Cellulose 56% ATR-Polymer- Tencel
 25000016	59% ATR-Polymer-Cellophane 58%ATR- Polymer- Tencel

 25000019	62% ATR-Polymer-Cellulose 64% ATR-Polymer-Cellophane 62% ATR-Polymer-Rayon 62% Polymer- Tencel
 25000067	53% ATR-Polymer-Cellulose 52% ATR-Polymer-Polyvinyl 52% ATR-Polymer-Ethylene vinyl acetate 51% ATR-Polymer-HDPE
 25000072	62% ATR-Polymer-Cellophane 62% ATR-Polymer-Rayon
	55% ATR-Polymer-Cellulose

25000106	
 25000128	64% ATR-Polymer-Polyester 64% ATR-Polymer-PET 62% ATR-Polymer-PBT
 25000130	55% ATR-Polymer
 25000204	64% ATR-Polymer-Polyester

NEXT STEPS

Wet deposition Samples: Extraction of microplastics from atmospheric wet deposition (rain water samples) are on-going. The rainwater samples are those collected in Quezon City in the year 2024.
Active sampling representing the dry season in Quezon City is also on-going. As of this date, a total of 25 TSP samples are obtained from the sampling site in UP Diliman College of Science Institute of Environmental Science and Meteorology Rof top from March to April 2025. Passive sampling.

Passive sampling of microplastics using the bucket-glass method (Brahney, et al, 2020) will be done in the following cities over the next months, tohave a representative collection all over the National Capital Region.

- Caloocan
- Pasig
- Mandaluyong
- Taguig
- Las Pinas
- Paranaque
- Valenzuela
- Pateros
- Malabon
- San Juan
- Navotas
- Pasay

The size and dimensions of the suspected MPs will be determined in the succeeding months.
All the remaining and upcoming samples will be subjected to FTIR-ATR as well.

APPENDIX 1: REFERENCES AND REVIEW OF RELATED LITERATURE

Title	Notes
Characteristics, depositions, sources and behaviors of Microplastics	
Fox, S., Stefánsson, H., Peternell, M., Zlotskiy, E., Ásbjörnsson, E. J., Sturkell, E., … Konrad-Schmolke, M. (2024). **Physical characteristics of microplastic particles and potential for global atmospheric transport: A meta-analysis**. *Environmental Pollution*, 342, 122938. doi:10.1016/j.envpol.2023.122938	• The paper sought to answer the question: “Which characteristics of microplastic particles promote atmospheric transport and deposition into remote regions, and how significant are these factors in determining distance transported from their sources?” • Method: Analysis of published papers; statistical analysis • The paper summarizes in its background portion classification of MPs based on color, polymer type, size, shape, etc. • The study found that there is a strong correlation between MPs physical characteristics and atmospheric transport. For example, PES and blue-colored MPs are more prevalent in sampling areas classified as remote.
Tatsii, D., Bucci, S., Bhowmick, T., Guettler, J., Bakels, L., Bagheri, G., & Stohl, A. (2024). **Shape Matters: Long-Range Transport of Microplastic Fibers in the Atmosphere**. Environmental Science & Technology, 58(1), 671–682. doi:10.1021/acs.est.3c08209	• The paper presented the gravitational settling of MPs in air of different sizes and shape by performing certain experiment • Method: experimental setup using Göttingen turret • The paper concluded that the shape of MP is important in its transport. Nonspherical MPs are more likely to have a larger horizontal and vertical transport range. Fibers are also seen to have slow settling velocity factoring in the fact that it can reach the stratosphere.
Jiang, K., Zhu, J., Su, K., Wang, X., Li, G., Deng, M., & Zhang, C. (2024). **Tracing the Transport and Residence Times of Atmospheric**	• The paper aimed at documenting temporal variations in and features of MP, examine its transport process and residence time, and find its correlation with other atmospheric matters. • Method: PM sampling; utilizing Be, Pb, Po as aerosol tracers

Microplastics Using Natural Radionuclides. Environmental Science & Technology, 58(35), 15702–15710. doi:10.1021/acs.est.4c02159	● The paper presents that the residence time of the atmospheric particles ranges from 9.47 - 22.85 days, having an average of 14.41 days. Radionuclides did not show positive correlation with MP abundance. But Po showed positive correlation with $PM_{2.5}$, most likely due to MPs' size of 20 microns to 5 mm. Negative relationships were also seen in MP residence time and abundance, implying higher MP concentration leads to increase of likelihood of particle aggregation and deposition.
O'Brien, S., Rauert, C., Ribeiro, F., Okoffo, E. D., Burrows, S. D., O'Brien, J. W., … Thomas, K. V. (2023). **There's something in the air: A review of sources, prevalence and behaviour of microplastics in the atmosphere**. Science of The Total Environment, 874, 162193. doi:10.1016/j.scitotenv.2023.162193	● The paper presented a summarisation and comparison of several papers concerning microplastics. ● The paper can be used to look at the trends and advances in MP studies.
Sampling Methods and Sampling Standardization	
Wright, S.L., Gouin, T., Koelmans, A.A. et al. (2021). **Development of screening criteria for microplastic particles in air and atmospheric deposition: critical review and applicability towards assessing human exposure**. *Micropl. & Nanopl.*1,(6), https://doi.org/10.1186/s43591-021-00006-y	● The paper reviews several papers on MP using a screening criteria. ● The paper forwards 11 criterias for assessing the studies concerning MPs: ○ Sampling method ○ Sampling duration ○ Sample processing and storage ○ Laboratory preparation ○ Clean air conditions ○ Negative control (blanks) ○ Positive control ○ Sample treatment ○ Filter/substrate composition ○ Polymer identification ○ Particle characterisation for human exposure ● Given the set criteria, scores assigned gauging the met standards.
Chen, G., Fu, Z., Yang, H., & Wang, J. (2020). **An**	● The paper presents a review of the common approaches in identification and quantification of MPs

overview of analytical methods for detecting microplastics in the atmosphere. TrAC Trends in Analytical Chemistry, 130, 115981. doi:10.1016/j.trac.2020.115981	as seen in various research papers.
Han, I.; Lee, C.; Belchez, C.; Shipper, A.G.; Wiens, K.E. (2024). **Microplastics in Urban Ambient Air: A Rapid Review of Active Sampling and Analytical Methods for Human Risk Assessment**. Environments,11(256). https://doi.org/10.3390/environments11110256	● The paper reviews research papers involving sampling and analytical methods towards microplastics. The aim of the paper is to provide insights regarding the most effective characterization of microplastics. ● The paper presents MP color types, shape, and composition as well as number and mass concentration (usually for inhalation dose)
Prata, J. C., Castro, J. L., da Costa, J. P., Duarte, A. C., Cerqueira, M., & Rocha-Santos, T. (2020). **An easy method for processing and identification of natural and synthetic microfibers and microplastics in indoor and outdoor air**. MethodsX, 7, 100762. doi:10.1016/j.mex.2019.11.032	● The paper presented a method for determining concentrations of airborne microplastics and fibre. ● The method is accomplished using hydrogen peroxide to remove organic matter and density separation using sodium iodide to remove minerals. Synthetic and natural discrimination of fibers was achieved following a diagram of the most common textile fibers. The method was said to produce a 94.4% recovery rate.
Zhang, Y., Kang, S., Allen, S., Allen, D., Gao, T., & Sillanpää, M. (2020). **Atmospheric microplastics: A review on current status and perspectives**. Earth-Science Reviews, 203, 103118. doi:10.1016/j.earscirev.2020.103118	● Analysis of published papers on microplastics, especially on used sampling and detection methods.

<table>
<tr><td colspan="2">Health Effects</td></tr>
<tr><td>Li, Y., Tao, L., Wang, Q., Wang, F., Li, G., & Song, M. (2023). Potential Health Impact of Microplastics: A Review of Environmental Distribution, Human Exposure, and Toxic Effects. Environment & Health, 1(4), 249–257. doi:10.1021/envhealth.3c00052</td>
<td>
This paper shows the increasing rate of MPs detected to different environments and human bodies.
It emphasizes how different organisms intake MPs and characterized by the type, sizes, source, and how many it reaches the human body to the smaller unit of its life.
The study discusses the toxicity mechanism of MPs. It shows the harmful effects it can cause in an “individual-tissue-cell-subcellular” manner. Additionally, it emphasizes the different factors to the MPs toxicity.
Oral intake of microplastics are due to its presence on what we eat or what utensils and its container are made out of. Additionally, MPs settle at agriculture systems that plants may acquire through their roots that may travel to its stem, leaves, and fruits.
Another pathway for MPs in human bodies is by inhalation. MPs present in the air are mainly PE, PS, and PET with size ranges of 10-8000 um. The study emphasizes that the main source of MPs in the atmosphere comes from the roads, covering 84% of MPs in the atmosphere. Additionally, sizes of MPs present in the air depends on the location.
Skin contact of MPs is also a pathway to the body. Products that humans use daily can contain MPs and be transferred to hands or face and will eventually go inside the body.
</td></tr>
<tr><td>Lee, Y., Cho, J., Sohn, J., & Kim, C. (2023/5). Health Effects of Microplastic Exposures: Current Issues and Perspectives in South Korea. Yonsei Med J, 64(5), 301–308. doi:10.3349/ymj.2023.0048</td>
<td>
The paper emphasizes the following as the health effects of intaking MPs through different systems of the body:

Digestive System:

Physical irritation can cause inflammation that can progress to various gastrointestinal symptoms.
Cause imbalance between beneficial and harmful bacteria that leads to abdominal pain, bloating, and changes in bowel habits
Toxic substances can be absorbed by the body that can cause nausea, vomiting, and abdominal pain.

Respiratory System:

Cause oxidative stress in airways that can progress into coughing, sneezing, shortness of breath, fatigue, and dizziness.

</td></tr>
</table>

	■ Causes mitochondrial damage in respiratory cells ○ **Endocrine System:** ■ Interfere with production, release, transport, metabolism, and elimination of hormones. ○ **Reproductive System:** ■ Infertility ■ Miscarriage ■ Congenital Malformations ○ **Immune System:** ■ Regulate expression of genes and proteins involved in immune response.. ● The paper mentioned that most of the chemicals used to synthesize plastic monomers are endocrine disruptors. Endocrine disruptors are hormonally active agents that cause cancer and reproductive-system disorders. ● Policies of different countries regarding the reduction of MPs and the year it is implemented are discussed in the study.
Sridharan, S., Kumar, M., Singh, L., Bolan, N. S., & Saha, M. (2021). **Microplastics as an emerging source of particulate air pollution: A critical review**. Journal of Hazardous Materials, 418, 126245. doi:10.1016/j.jhazmat.2021.126245	● The paper summarizes the current status, advancements, and implications in the field of microplastics. Specifically, the study covers how MPs are distributed to any biome and limited information regarding its health impacts. Additionally, the paper provides imminent implications to the environmentalists, researchers, and policymakers.
Case Studies	
Romarate, R.A., Ancla, S.M.B., Patilan, D.M.M. et al. (2023). **Breathing plastics in Metro Manila, Philippines: presence of suspended atmospheric microplastics in ambient air**. Environ Sci Pollut Res 30, 53662–53673 . https://doi.org/10.1007/s11356-023-26117-y	● A first case study focusing on detecting MPs in the air of the cities in Metro Manila. The study discovered the most cities with microplastics and their characteristics. ● The sampling was conducted in 16 cities and a municipality of Metro Manila on December 16 to 31, 2021. The study performed a 12-hour sampling. ● Air sampling was executed by using a respirable dust sampler with an intake flow rate of 1.4 and A GF/C whatman filter paper to filter the atmospheric microplastics from the sanctioned air. Additionally, it was placed near roads with a height of 1.5 meters up from the ground to simulate the average human

	height. ● Visual sorting of MPs collected was done by embedding in individual glass slides with a label and using a binocular stereo microscope mounted with a camera. ● Classification of MPs is executed with the use of a compound microscope mounted with Moticam BTX8 and classified by shape, color, and size. ● Validation was done by placing suspected MPs in a glass slide and subjected to Shimadzu Fourier-Transform Infrared Spectroscopy (FTIR).
M Afiq Daniel Azmi et al. (2023). **Analysis of suspended atmospheric microplastics size at different elevations in Universiti Teknologi Malaysia, Kuala Lumpur**. IOP Conf. Ser.: Earth Environ. Sci. 1144 012009	● ● Sampling location was conducted in Universiti Teknologi Malaysia with two separate elevations labeled as H1 (1.5 meter from the ground) and H2 (10 meters from the ground). ● Air sampling was executed with the use of SIBATA High-Volume Sampler HV-1000R and Glass-fibre filters for 10 weeks. Each samples require 24 hours of sampling time with a flowrate of 1000L/min ● The collected samples were stored in a cleaned beaker and funnel with the use of ethanol and ultra-pure water. The beaker was covered with aluminum foil to avoid contamination. ● Each sample is treated with 150 ml 30% hydrogen peroxide, H_2O_2 solution (R&M Brand, 1477-80) and allowed to stand for 8 days in a fume hood until there's no foamy reaction. Moreover, the samples were vacuum filtered onto a 47 mm diameter microfiber glass filter and placed in a petri dish before drying for roughly 24 hours/1440 minutes in an oven at 60 degrees celsius. ● Visual detection of count, colors, and shape of collected MPs was done by digital stereo microscope. ● An equation of EDI (particles/kg.day)=c.m/BW was also used to estimate the daily abundance of MPs intake. ● The study relates the elevation to MP sampling with a result of H1 with collected MP size ranges 70 - 1855 um and 102 - 5429 um for H2. This suggests that large MPs are common in highly elevated places. ● The difference in sizes between elevation may be related to the meteorological effects such as wind speed, direction, and etc..

Yao, Y., Glamoclija, M., Murphy, A., & Gao, Y. (2022). **Characterization of microplastics in indoor and ambient air in northern New Jersey**. Environmental Research, 207, 112142. doi:10.1016/j.envres.2021.112142	● A case study in the indoor establishments in Northern New Jersey that detects the MPs present. The data collected regarding the MPs found were characteristics, amount, colors, and shapes. ● In indoor passive air sampling, it is conducted in a classroom, hallway, and an office of Rutgers University-Newark Campus and in a household residential area. The materials used in sampling are Whatman Quartz Filter (2.2 um, 47 mm) in a glass petri dish and a pre cleaned glass petri dish. The Whatman Quartz Filter was pre-baked in a Thermo Scientific Thermolyne 30,400 furnace at 550 degrees celsius. The indoor sampling was made from April 18, 2019 to May 2, 2019. ● In total atmospheric deposition sampling, it is conducted on the roof of Bradley Hall (approximately 25 m above the ground) on Rutgers University-Newark campus. The materials used in sampling are four stainless steel funnels (OD: 0.213 m) connected to 4-L glass jars, and the total sampling surface area was 0.142 m^2. The funnels were rinsed with Milli-Q ultrapure water (18.2 MΩ cm) three times to recover all fallout fibers that might adhere to the funnel walls. ● In ambient atmosphere particulate matter sampling, it is done where the indoor passive air sampling was made. The materials used to collect fine and coarse particulate matter (PM) for this are Thermo ScientificTM Partisol 2000i-D Dichotomous Air Sampler with a flowrate of 1.67 L/min for PM10 sample and 15 L/min for PM2.5 sample and the pre-cleaned Whatman Quartz Filter that was used in indoor passive air sampling. Filters were covered with the pre-baked aluminum foil during trips to and from the sampling sites to avoid contamination. ● For sample counting, big samples collected on a Whatman quartz filter were counted using the Leica Zoom 2000 Stereo microscope. On the other hand, small particles were counted with the use of a WITec Confocal Raman Microscope Alpha300 R. ● Air samples were examined with the use of Scanning Electron Microscope (SEM) and Raman Spectroscopy. The surface morphology and elemental composition of the irregular collected samples are examined by a Scanning Electron Microscope (SEM) coupled with energy dispersive X-ray spectroscopy (Hitachi S-4800 SEM with EDAX EDS). Before SEM analysis, the samples were coated with Iridium (Ir) using a Ted Pella sputter coater. On the other hand, Raman spectra of air

	fallout samples were acquired using a WITec alpha300 R equipped with a frequency-doubled Nd:YAG (532 nm) excitation laser and a 100x (NA 0.75) Zeiss long working distance objective lens. The laser intensity used ranged from 2.7 mW to 2.9 mW. Spectral peak positions were calibrated against a silicon standard. Spectra were collected on a Peltier-cooled Andor electron multiplying charge-coupled device (EMCCD) chip after passing through a f/4300-mm focal length imaging spectrometer using 600 grooves/mm grating. The WITec Project PLUS software was used to collect and process all Raman data. A Savitzky-Golay filter was used to smooth the spectra, and in some cases, a background subtraction using a rounded shape fit was applied to remove fluorescence. ● It is found that MP fibers are more likely present in households. However, it is also noted that it depends on the nature and environment of the household or other indoor facilities.
Jannah, Baiq Raudatul, Maharani, Hanifa Aulia, Rahmawati, Suphia, Nugroho, Adam Rus, & Abdull, Norhidayah Binti. (2024). **Occurrence and characteristic of microplastics in suspended particulate, a case study in street of Yogyakarta**. E3S Web of Conf., 485, 06008. doi:10.1051/e3sconf/2024 48506008	● The 4 sampling locations were conducted on the intersection of Yogyakarta arterial road called Ringroad. The sites are defined as West Ringroad (WR) that sampled at March 2023; South Ringroad (SR) that sampled at April 2023; East Ringroad that sampled at June 2023; lastly, North Ringroad that sampled at June 2023. The sampling was conducted in a span of 24 hours. ● Active sampling method was done using a High Volume Air Sampler (HVAS) with the gravimetric method and a flow rate of 1.2m^3/second, and a microfiber filter paper size 60 x 60 cm (Staplex Type TFAGF810). The height of the sampler is 1.2 m to simulate the breathing height of an adult. Each HVAS was placed 100-200 meters from heavy traffic. Moreover, environmental parameters such as wind speed, temperature, humidity, and pressure were also recorded 24 times with a span of 1 hour each in 24 hours. ● Examination of samples is done by Filter paper cut into 4 parts and placed in a glass beaker with 80 mL of deionized water. It was then placed in an ultrasonic bath for 40 minutes. The filters were then rinsed with deionized water and removed from the beakers. The washed airborne particles were put in the oven at 60°C for 24 hours to dry it. To eliminate any organic debris from the samples, the dried particles were treated with 80 mL of 30% H_2O_2 for 6 days. The samples were then immersed in 30 mL of potassium

	iodide solution with a density of 1.6 g/cm3, shaken for 10 minutes at 350 rpm, and allowed to settle for 1 hour then it gets filtered. The solution then centrifuges for 3 minutes at 4000 rpm, after that gets filtered through Whatman 0.45 μm filter paper with a vacuum pump that is connected to a magnetic filter funnel. The filter paper containing MPs objects were air dried for 24 hours. Next, the Whatman filter paper then divided into 4 quadrants, each quadrant was analysed using Olympus microscope UTV0.5XC-3 with 4x/0.1 magnification that connected to a computer. The Microscope used to observe the amount, color, and physical form of microplastics. ● The study emphasizes that roads of urban areas accumulate a variety of MPs with the factors of the establishments surrounding the area and the frequency of vehicles using the road. ● The results suggest that a high number of MPs are accumulated on the road that vehicles frequently use. ● The use of an ambien filter sampler was used for sampling, a common method in collecting MPs outdoors.
Chen, E.-Y., Lin, K.-T., Jung, C.-C., Chang, C.-L., & Chen, C.-Y. (2022). **Characteristics and influencing factors of airborne microplastics in nail salons**. Science of The Total Environment, 806, 151472. doi:10.1016/j.scitotenv.2021.151472	● The paper revolved in understanding the presence of MPs in nail salons. The findings of the study was that the concentration of indoor MPs is greater than outdoor. ● The sampling was done in different 6 salons of Taiwan, indoor and outdoor. The sampling was conducted 3 - 4 days for 10 continuous hours each day from February to April 2021. The indoor sampling was done with a distance to the working area to avoid interfering, while outdoor sampling was placed at the balcony or in the adjoining arcade of the nail salon. ● Air sampling was executed with the use of 25 mm Cassettes (3 pieces, SKC, Dorset, UK) with Silver member filter (25 mm, 0.2 um, STERLITECH, Kent, WA, US) at an airflow of 9 L/min to collect indoor and outdoor. ● For analysis of samples, the filter was placed in a glass beaker containing 20 mL of deionized water, and the sample was placed in an ultrasonic bath for 40 min. The filter was washed with deionized water (approximately 5 mL) and removed from the glass beaker. Subsequently, the filter was dried in an oven at 60 °C for approximately 7–8 h. Furthermore, 30% H_2O_2 (Honeywell/Fluka, Minneapolis, MN, US) was added to the sample for 6 days to remove potential organic matter. In addition, 25 mL of $ZnCl_2$ (98%; Alfa Aesar, Ward Hill, MA, US) solution with a density

	of 1.7 g/cm^3 was added to the sample, which was shacked at 250 rpm for 10 min before being allowed to settle for 1 h. This clear solution was centrifuged at 4000 rpm for 3 min; then, the upper liquid was taken by using a pipette and evenly dropped into a Whatman filter (47 mm, 0.45 μm) with a vacuum pump; thus, we assumed that particles on the filter were evenly distributed during the filtration procedure. These procedures were conducted three times for each sample. The filter was stored in a clear box and air-dried until analysis. ● For analysis, samples were examined with the use of a microscope (Revolve, ECHO, San Diego, CA, US) with atleast 20 fields of view from each filter. Additionally, Fourier tranform infrared spectroscopy (FTIR, Nicolet iN10; Thermo Fisher, Scientific, Waltham, MA, US) was used to analyze polymer composition and sizes of MPs (excluding MPs with size >5000 um). The study further analyzed polymer compositions by using polymer libraries, with at least 70% similarity for confirmation. ● A difference in the data collected about MPs in indoor and outdoor nail salons was also presented. The collected MPs in salons are mainly acrylic, rubber, and PUR. On the other hand, outdoor MPs collected are mostly related to tires, road dusts, and road markings such as acrylic. ● There is a difference in the type of MPs present in other indoor areas such as in households or offices than salons. ● The study highlighted that the common materials present and activities are factors in the production of MPs. ● The air sampling was executed with the use of 25 mm cassettes with silver member filters at an airflow of 9 L/min to collect indoor and outdoor of the salon.
Kernchen, S., Löder, M. G. J., Fischer, F., Fischer, D., Moses, S. R., Georgi, C., … Laforsch, C. (2022). **Airborne microplastic concentrations and deposition across the Weser River catchment**. Science of The Total Environment, 818, 151812. doi:10.1016/j.scitotenv.2021.151812	● The case study emphasizes that MPs abundance was not linked directly to the local population density but rather to the unique conditions of the specific sites combining meteorological factors and many potential local sources.

Dris, R., Gasperi, J., Mirande, C., Mandin, C., Guerrouache, M., Langlois, V., & Tassin, B. (2017). **A first overview of textile fibers, including microplastics, in indoor and outdoor environments**. Environmental Pollution, 221, 453–458. doi:10.1016/j.envpol.2016.12.013	● A case study done in an indoor and outdoor environment of an apartment and office. The results showed that the concentration of indoor MPs is greater than outdoors. ● The sampling was done in different indoor sites: specifically, the living room of two private apartments (labelled as A and B) and an office (work place) of University of Paris-Est-Creteil. On the other hand, outdoor sampling was done on the roof of the office building. For each site, sampling was conducted in February, May, July, and October of 2015, covering all four seasons of the location. ● In the apartment, 4 hours of air sampling was carried out in the morning and 7 hours in the afternoon. On the other hand, sampling in the office and on its roof are carried out continuously between 10 and 40 hours. ● For indoor sampling, sampled volumes range between 2 and 5 m^3, while in outdoor sampling, sampled volumes range between 5 and 20 m^3. ● Air sampling was carried out with the use of a pump (Stand-alone sampling pump GH300,Deltanova,France) with an air flow of 8 L/min and a quartz fiber GF/A Whatman filter (1.6 um, 47 mm) ● Passive air sampling was conducted with the use of quartz fiber GF/A Whatman filter (1.6 um, 47 mm). It was exposed in the apartments and the office per season. The duration of sampling was between 4 and 15 days. ● Samples of vacuum cleaner bags of the apartments were also taken and it was passed through a 2.5 mm mesh size sieve. A mass of 5.5 mg was introduced in a separation funnel with 50 ml of Zinc Chloride (ZnCl2 - 1.6 g/cm^3) for density separation. ● Analysis of samples are executed with the use of stereomicroscope (Leica MZ12 - Buffalo - United States) for observation. Fibers were counted and measured with software Histolab® (Microvision instruments - Evry - France) coupled with the stereomicroscope. Chemical characterization was done with the use of Fourier Transform Infrared (FT-IR) microspectroscopy (Microscope LUMOS FT-IR - Brucker - Champs-sur-Marne, France) coupled with an ATR (Attenuated Total Reflectance). ● The dominant type of MPs found was fiber, which is commonly found in households and offices. ● The air sampling was executed with the use of a stand-alone sampling pump that is allowed to sample 8 L/min of indoor air and a quartz fiber GF/A

	whatman filter (1.6 um, 47 mm).