

Research Article

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Detection, Isolation and Characterization of Microplastics in Commercial Salt Samples using Polarized Light Microscopy

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ABSTRACT

Over the past few decades, microplastics have been globally recognized as a prevailing contaminant in marine, freshwater, as well as terrestrial ecosystems. The recent study about the all-pervasive nature of microplastics creates an alarming situation for the researchers to know about the ill effects, and ingestion of microplastics in humans. Though there are multiple ways for humans to get exposure to microplastics, salt is one of the unavoidable food ingredients that does not have any other alternative. The substantial evidence for the presence of microplastics in salt has been already established, but the extraction, quantification, and characterization of microplastics are yet challenging. In this work, we addressed this research gap by using a polarization microscope to characterize different microplastics under different stress levels. Commercial salt samples analyzed including sea salts, rock salts, and pink salts have been purchased from the local market. Total Solid Substances (TSS) were separated from soluble salt through the chemical digestion method and filtration. The extracted particles have been characterized through a polarization microscope, and the chemical confirmation of the particles was done through FTIR spectroscopy. Rock salts and pink salts were more abundant with TSS than sea salts. Four out of seven salt samples were found contaminated with microplastics. Polyethylene, Nylon, Polycarbonates, and Mixed microparticles were the prominent microplastics isolated and characterized.

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Received: September 01, 2026; **Accepted:** September 09, 2026; **Published:** September 26, 2026

Keywords: Microplastics, Characterization, Polarization Light Microscope, Birefringence, FTIR Spectroscopy

Introduction

Microplastics are a significant and inevitable global threat to the environment and humans. Plastics, as a product, were created as an industrial requirement of a material that shows the flexibility of rubber but provides the inertness of glass. After many decades, people realized that behind this convenience lies a mountain of trouble, in the form of microplastics [1]. The main cause of this microplastic is the mismanagement of plastic waste, even though there is an awareness about it; poor waste management creates a lot of plastic pollution. There is inadequacy in the awareness of disposable methods, waste management infrastructure, and a lack of facilities for recycling. Consequently, a lot of plastic products are being burnt along with other wastes, which creates microplastics in the air, and they get into water sources by surface runoff, wastewater treatment plants, atmospheric deposition or agricultural or aquaculture activities. Encyclopedic and open-ended research projects are increasing, painting a stark and sizable picture of the negative impact of microplastics on us. The presence of microplastics in human organs and tissues confirms the

consumption of microplastics by humans and petrifies everyone about the penetration of microplastics into living systems [2-4]. Microplastics are suspected to be the cause of many health issues, but it is yet to be confirmed that it is purely because of microplastics [5]. The all-pervasive nature of microplastics and the ambiguity about being the genesis of health issues prompt microplastic researchers to know about the ill effects and the ingestion of microplastics in humans. Though there are multiple ways for humans to get exposure to microplastics, salt is one of the unavoidable food ingredients that does not have an alternative. The substantial evidence for the presence of microplastics in salt has already been established, but the extraction, quantification, and characterization of microplastics are still challenging. The presence of microplastics in salt was first identified by a group of researchers from China, followed by other countries [6-15]. In India, the awareness about microplastics is generously growing as evidenced from several studies that have happened in the recent past [16-20]. A recent trend is to utilize polarization microscope as a non-invasive method for the identification and characterization of different microplastics and differentiating it from other organics but there is a wide research gap on whether it can be used as a characterization technique for microplastics or not [21-26].

The major limitation of this technique is that birefringence is very sensitive to stress levels, and few microplastics are non-birefringent. In this study, we addressed this by using a polarization microscope to characterize standard microplastics subjected to various stress levels by applying different pre-determined pressures. Comparison of the birefringent properties of standard plastics was made with microplastics isolated from different commercial salts. FT-IR was used as a method to characterize isolated microplastics from different salt samples to corroborate with the microscopy data.

Materials

In the present work, seven commercial salts were chosen, which include sea salts, rock salts, and pink salts. These brands were specifically chosen, as they are being promoted as purified salts, and they are sold in supermarkets of Bangalore. Each brand has been assigned to a specific code, and the source, type, and ingredients of all the samples are given in Table 1. All glassware, and MCE membrane filter paper with 0.2 micron pore size and 90 mm diameter have been purchased from Sigma-Aldrich Chemicals Private Limited. Hydrogen Peroxide (30% W/V) was purchased from Isochem Laboratories in Kochi. The IKA overhead stirrer along with hot plates was used for chemical digestion. Themisto fine tweezers and dissecting needles have been used in the process of removing microplastics from the filter paper.

Characterization Techniques

Polarized Microscopy Method

The Polarization light microscope “Leica DM750M” has been used to characterize microplastics. This microscope has already been utilized to authenticate food samples through the birefringence property of the food sample with or without adulterants [27]. The microplastic particles, separated from the solution were analysed by two different modes of the microscope. Certain class of microplastics were expected to reveal a set of colour bands, as they exhibit different birefringence.

Light Mode

In this mode, the polarizer and analyzer from the microscope have been removed, and the microscope acts as a normal stereomicroscope.

Dark Mode

In this mode, the polarizer has been rotated and kept exactly perpendicular to the analyzer and is qualified as a dark mode as light rays are blocked.

FTIR Spectroscopy

Nicolet Summit X FT-IR spectrometer, Thermofisher was utilized for the characterization of microplastics. The samples were scanned between 500 cm⁻¹ and 4000 cm⁻¹ with a resolution of 4 cm⁻¹.

Methods

Preparation of Standard Microplastics

To characterize microplastics having different birefringence at different stress/pressure situations, there are no comparisons possible as on date. In order to estimate the situations under which plastics undergo degradation to form microplastics and how they persist in sea/landfills, it is imperative to compare the birefringence to qualitatively determine the plastic types and to understand the stress/pressure under which they are formed and persist. As the polarization technique is at its infancy in microplastics research, we prepared the microplastics from authentic plastic pellets and plastic discard materials and, characterized them through a polarization microscope to know the stress-induced birefringence pattern of the microplastics. The stress has been induced in the material by using a compression moulding machine; each type of microplastic has been subjected to different levels of stress. The maximum level of pressure applied to each microplastics is 2000 psi. The variation in the birefringence pattern has been observed at 0 psi, 500 psi, 1000 psi, 1500 psi, and 2000 psi. The IR pattern of the same microplastics has been obtained by using the FTIR instrument and the peaks have been compared with the available FTIR data [28]. Images of the plastic materials that were used to prepare microplastics are given in Figure 1. Plastic pellets were used for polyethylene, polypropylene, and polycarbonate microplastics. Nylon filter paper was used to generate nylon microplastic. PVC pipe and PET bottles were used to prepare the microplastics of PVC and PET, respectively.

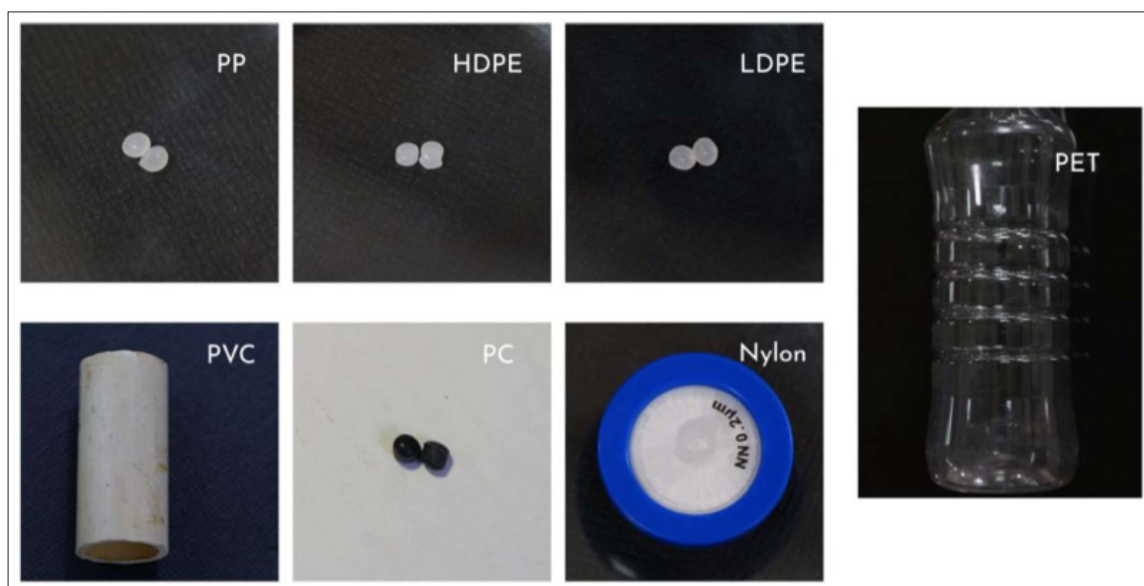


Figure 1: Images of Plastic Materials

Extraction of Microplastics from Salt

Chemical Digestion of Salt with H_2O_2

The most difficult part in identifying microplastics in environmental matrices is to separate them from other components of the matrix and from biofouls. The standard protocol to separate microplastics is either density separation or chemical digestion. In the process of chemical digestion, hydrogen peroxide degrades organic material and removes biofouling, leaving the microplastics devoid of biofouling material. In the case of salt, we followed the procedure that was already mentioned in the literature and found it to be adequate [6]. Each salt packet was divided into a portion of 150 g, and 50 ml of H_2O_2 was added to it. This mass was stirred at 450 rpm using a digital overhead stirrer after being heated using a hotplate at $65^\circ C$ for thirty minutes. After that period, 500 ml of distilled water was added to the stirred mass to dissolve the salt completely and the solution was kept at room temperature for 24 hours. This process was repeated for all brands of salt.

Extraction of TSS Through Vacuum Filtration Setup

The next step in the process is to separate the Total Solid Substances (TSS) from the solution: For this, the salt solution was filtered through a vacuum filtration setup. Buchner funnel with 90mm internal diameter and 0.2-micron filter paper was kept on the

funnel, and the entire setup was connected to a vacuum pump. The solution was poured into the setup to separate the TSS from the solution. After this, the filter paper was carefully removed from the Buchner funnel through fine tweezers and placed on a petri plate. The filter papers were dried at $65^\circ C$, and it was kept only for five minutes to avoid the degradation of microplastics. TSS particles from the dried filter papers were carefully removed with the fine tweezers, and the particles were examined under the polarization light microscope.

Results and Discussion

The Total Solid Substances (TSS) of each brand are given in Table 1. TSS values differ from one brand to another brand; also, rock salts have higher TSS particles than sea salts. These particles are a mixture of other additives and contaminants in salt. Though all sea salts have the same ingredients on the label, the ratio of the mixture of other additives in the salt varies, which results in the variation of the amount of TSS. Also, in one of the branded salts, some fine fibers have been isolated as part of the TSS, suggesting the region of sourcing of the sea water associated with clothing industry. The bar graph of TSS particles for all the brands is given in Figure 2.

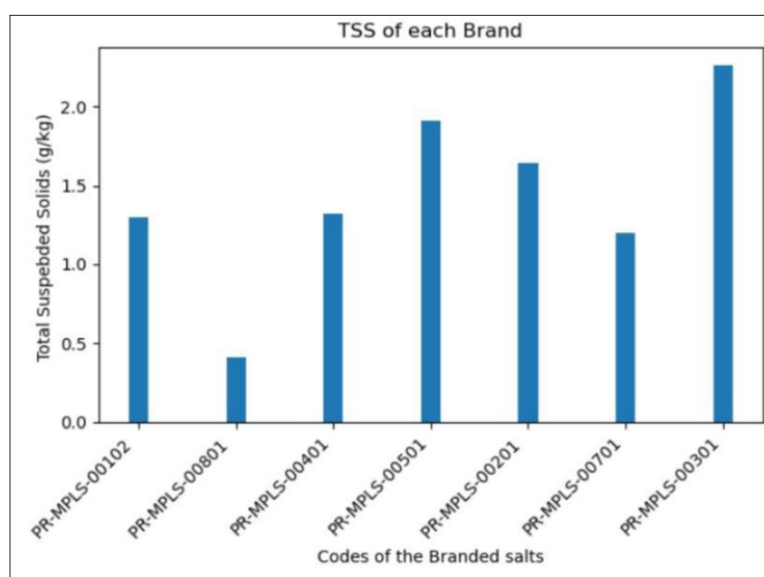


Figure 2: Bar Graph of Total Solid Substances of the Brands

Table 1: Total TSS Values of Each Branded Salt

Sample Code (g/kg)	Type of the Salt	Source	Ingredients	Presence of Microplastics	Total TSS
PR-MPLS-00801	Sea Salt	Arabian Sea, Gujarat.	Edible common salt, potassium Iodate, Anti caking agent.	Yes	0.41
PR-MPLS-00102	Sea Salt	Bay of Bengal, Tamil Nadu.	Edible common salt, potassium Iodate, Anti caking agent.	Yes	1.30
PR-MPLS-00401	Sea Salt	Arabian Sea, Gujarat. Bay of Bengal, Tamil Nadu.	Edible common salt, potassium Iodate, Anti caking agent.	No	1.47

PR-MPLS-00501	Himalayan Rock Pink Salt.	Rocks from Himalayan region	Natural rock, Sendha Namak	Yes	1.913
PR-MPLS-00201	Rock Salt.	Natural rock	Edible common salt, Potassium Iodate.	Yes	1.639
PR-MPLS-00701	Rock salt	Natural rock	Rock Salt Potassium Iodate	No	1.20
PR-MPLS-00301	Himalayan Rock pink salt	Rocks from Himalayan region	Rock Salt and Potassium Iodate	No	2.26

Characterization of Standard Microplastics Through Polarization Microscope

Collection of microscopic images of the microplastics from standard plastic samples and understanding their birefringence owing to the anisotropy is important to establish a comparison of the isolated microplastic particulates from commercial samples with the standards established. The microplastics might have been generated deep in the waters or in landfills with varying stress/pressure conditions. Therefore, standard plastic particulates were subjected to pre-determined higher-pressure conditions and their birefringence captured. The microplastics isolated from different salt samples were compared against these standards.

High Density Polyethylene (HDPE)

Microscopic images of the HDPE particles without stress in light mode and dark mode, and the stress induced birefringence images of HDPE particles are given in Figure 3. It can be observed that there is no variation in the particles under light mode, under dark mode few colours are dominant for different pressure levels. The dominant colours are given in Table 2. Particles started to reveal colours at 1000 psi; brown, metallic silver and blue colours are dominant at most of the pressure levels. Yellow colour has been revealed at 2000 psi. The FTIR pattern of the same material is given in Figure 4, and the peaks are matching with prominent peaks of polyethene.

Table 2: The Dominant Colours of HDPE Under Crossed Polars with Different Pressure Levels

Pressure Levels	Dominant colours under Crossed Polars
0 psi	Brown, Grey and most of the parts are dominant by Metallic silver.
500 psi	Brown, Blue and Metallic silver.
1000 psi	Brown, Blue and Metallic silver.
1500 psi	Brown, Blue and Metallic silver.
2000 psi	Brown, Blue, Yellow and Metallic silver.

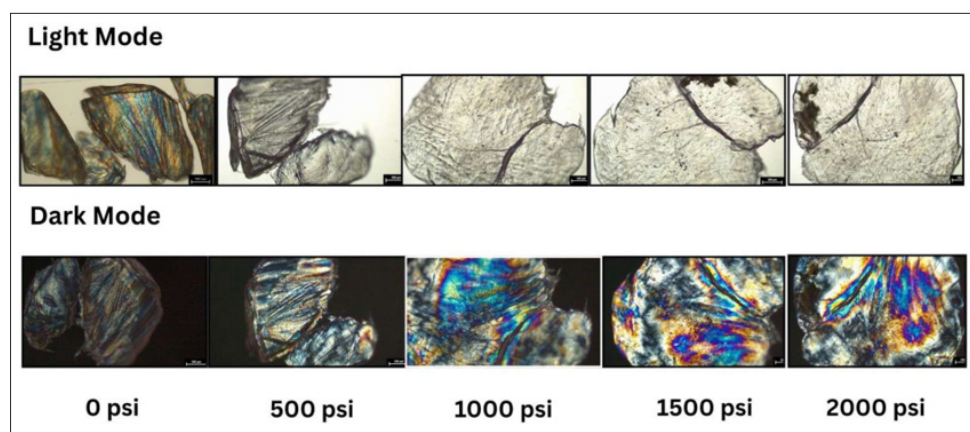


Figure 3: Polarized Microscopy Images of Standard High-Density Polyethylene at Different Pressure Levels

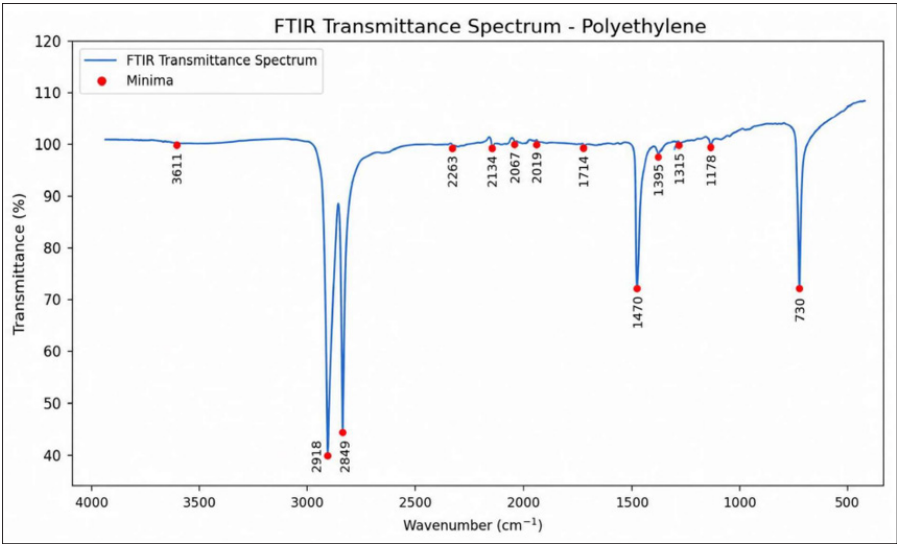


Figure 4: FTIR Peaks of HDPE Low Density Polyethylene (LDPE)

Microscopic images of LDPE particles in light mode and dark mode are given in Figure 5. The dominant colours under each pressure levels are given in Table 3. Brown and blue colours have been observed under all the modes; purple and green colours are dominant after the pressure level of 1000 psi. Purple and green colours are the unique colours which differentiate it from HDPE. The prominent peaks of the IR pattern which is given in Figure 6 are matching with LDPE.

Table 3: The Dominant Colours of LDPE Under Crossed Polars with Different Pressure levels

Pressure Levels	Dominant colours under Crossed Polars
0 psi	Blue, Light, green and yellow.
500 psi	Blue, Metallic silver.
1000 psi	Brown, Blue and Metallic silver.
1500 psi	Brown, Blue, yellow, purple and green.
2000 psi	Brown, Blue, yellow, purple and green.

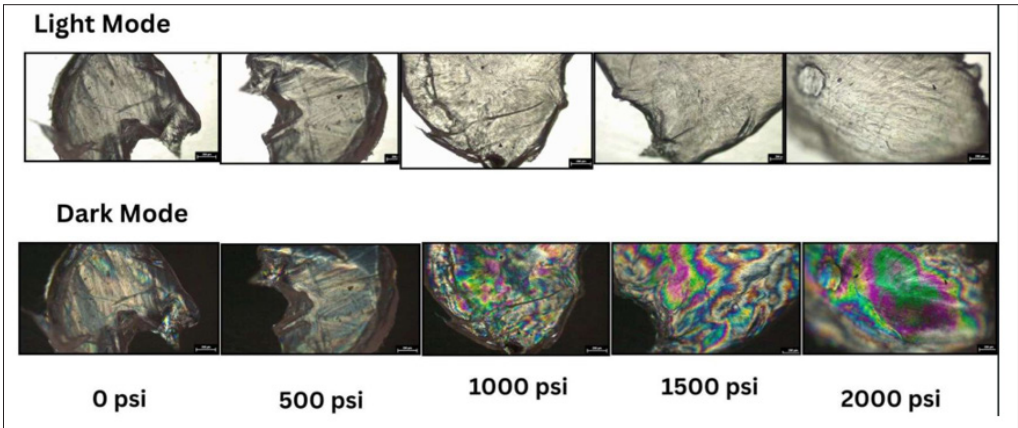


Figure 5: Polarized Microscopy Images of Low-Density Polyethylene Under Different Pressure Levels

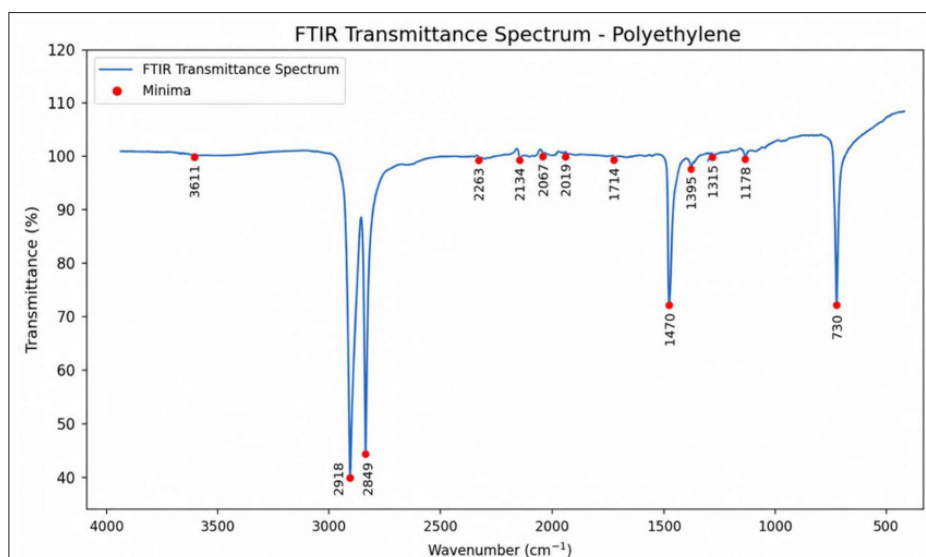


Figure 6: FTIR Peaks of LDPE

Polypropylene (PP)

The microscopic image of PP material without stress and stress induced birefringence images in light mode and dark mode are given in Figure 7. The dark mode images are much intense than HDPE and LDPE. The dominant colours under each pressure levels are given in Table 4. Polypropylene is dominant in both the colours which was dominant in HDPE and LDPE. The FTIR peaks are given in Figure 8 and matches with polypropylene.

Table 4: The Dominant Colours of PP Under Crossed Polars with Different Pressure Levels

Pressure Levels	Dominant colours under Crossed Polars
0 psi	Metallic silver and brown.
500 psi	Green, violet, blue, brown and Metallic silver.
1000 psi	Brown, Blue and Metallic silver.
1500 psi	Metallic silver, brown, purple and blue.
2000 psi	Metallic silver, blue, brown, yellow, purple and green.

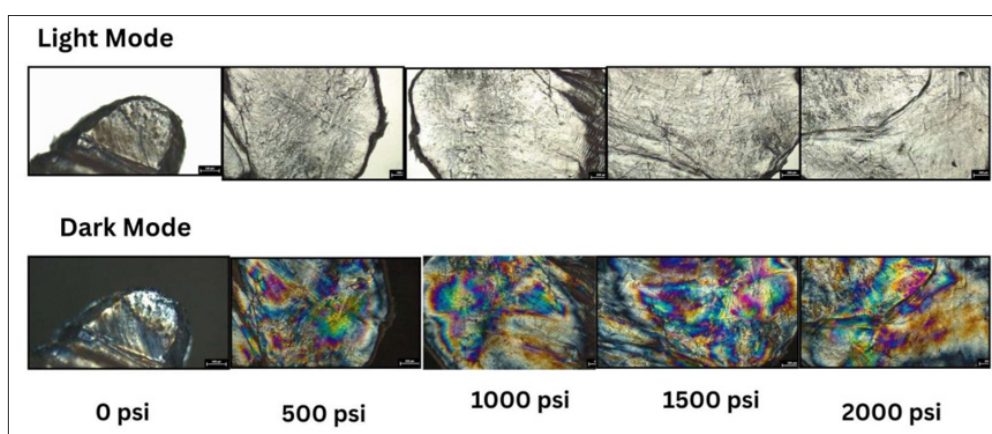


Figure 7: Polarized Microscopy Images of Polypropylene Under Different Pressure Levels

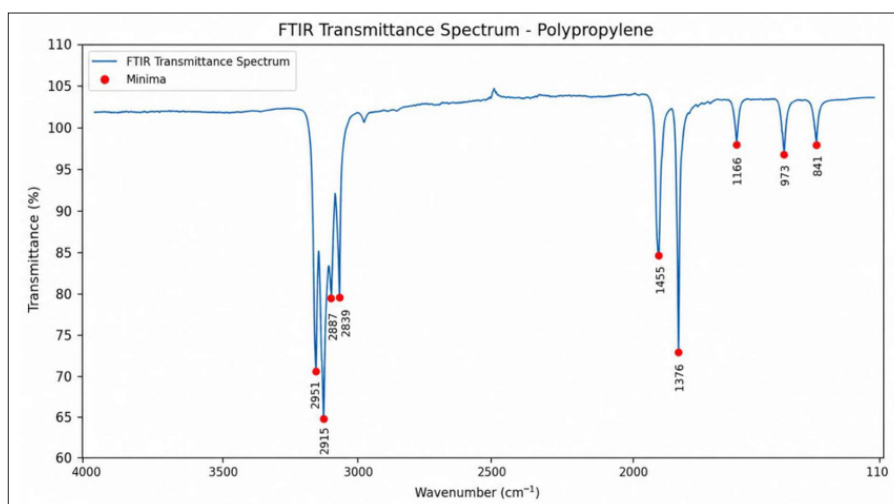


Figure 8: FTIR Peaks of Polypropylene

Polyethylene Terephthalate (PET)

Microscopic images of the PET particles without stress in light mode and dark mode, and the stress induced birefringence images of HDPE particles are given in Figure 9. The strength of the birefringence in PET is very less which differs this from HDPE, LDPE and PP. The colours of the materials are given in Table 4. The prominent peaks of FTIR are given in Figure 10 which matches with PET.

Table 5: The Dominant Colours of PET Under Crossed Polars with Different Pressure Levels

Pressure Levels	Dominant colours under Crossed Polars
0 psi	Metallic silver, purple and yellow.
500 psi	Metallic silver, purple, blue, yellow and green.
1000 psi	Metallic silver, purple, blue, green and yellow.
1500 psi	Metallic silver and blue.
2000 psi	Metallic silver, purple, yellow and blue.

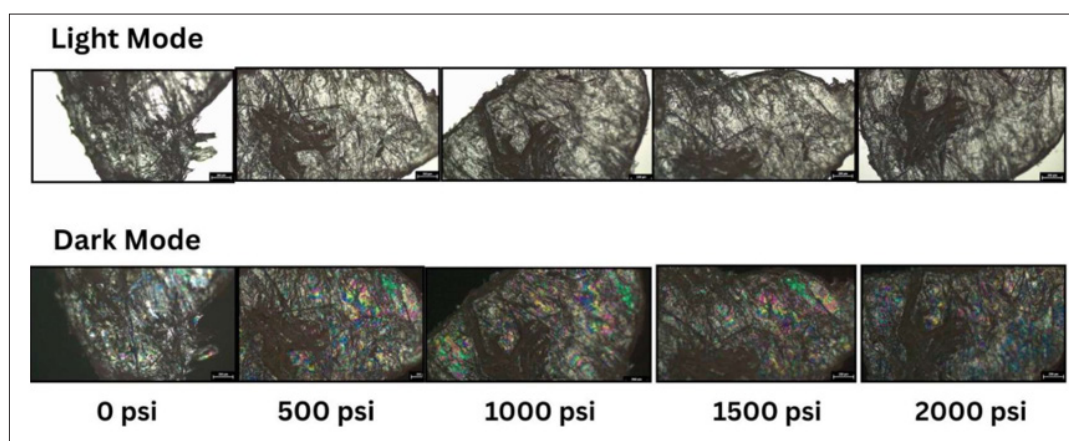


Figure 9: Polarized Microscopy Images of Polyethylene Terephthalate Under Different Pressure Levels

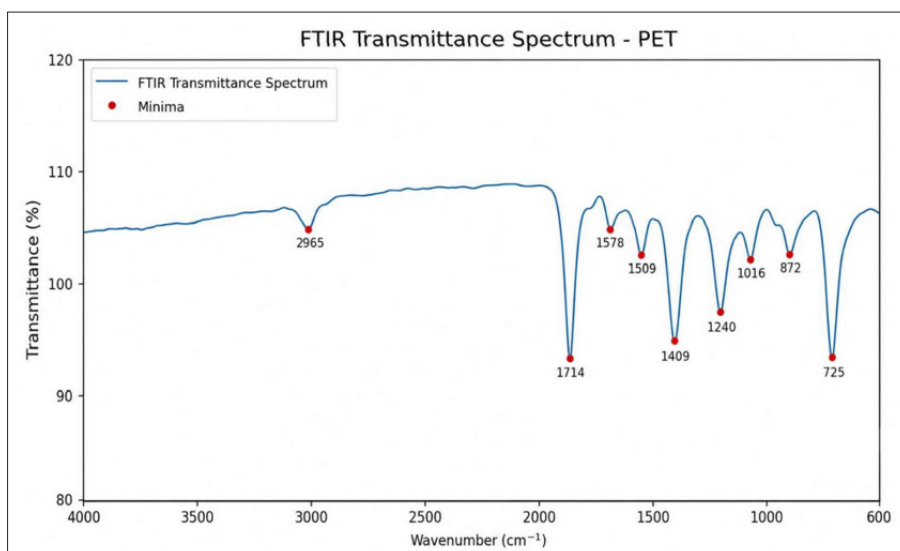


Figure 10: FTIR Peaks of Polyethylene Terephthalate

Nylon

The polarized microscopic images of the particles are given in Figure 11. Same particles have been subjected to different stress level, and it was observed that there was no revelation of colours up to 2000psi. The FTIR peaks are given in Figure 12, and, and the prominent peaks are matching with nylon.

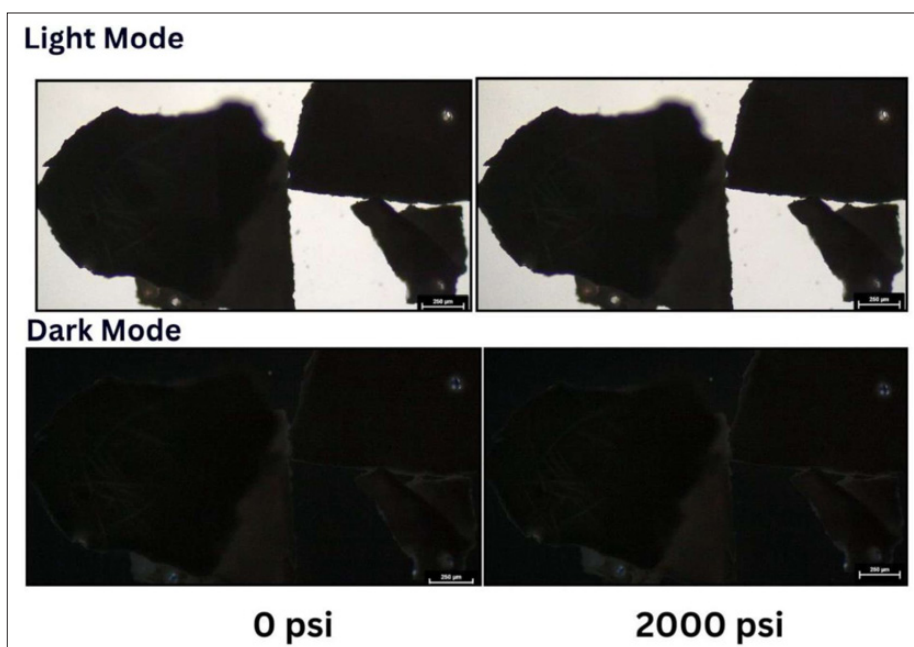


Figure 11: Polarized Microscopy Images of Nylon Under Light Mode and Dark Mode at Different Pressure Levels

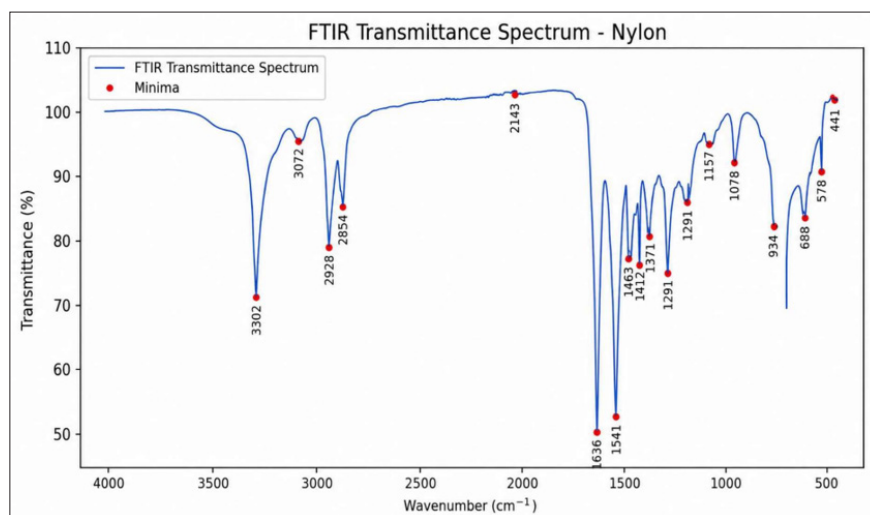


Figure 12: FTIR Peaks of Nylon

Polyvinyl Chloride (PVC)

The microscopic images of the material without stress and the stress-induced birefringence images of the material are given in Figure 13. In this case, it does not reveal any colours both before and after the stress. Hence, it can be noted that PVC materials are non-birefringent. The corresponding IR pattern is given in Figure 14. The prominent peaks match with PVC.

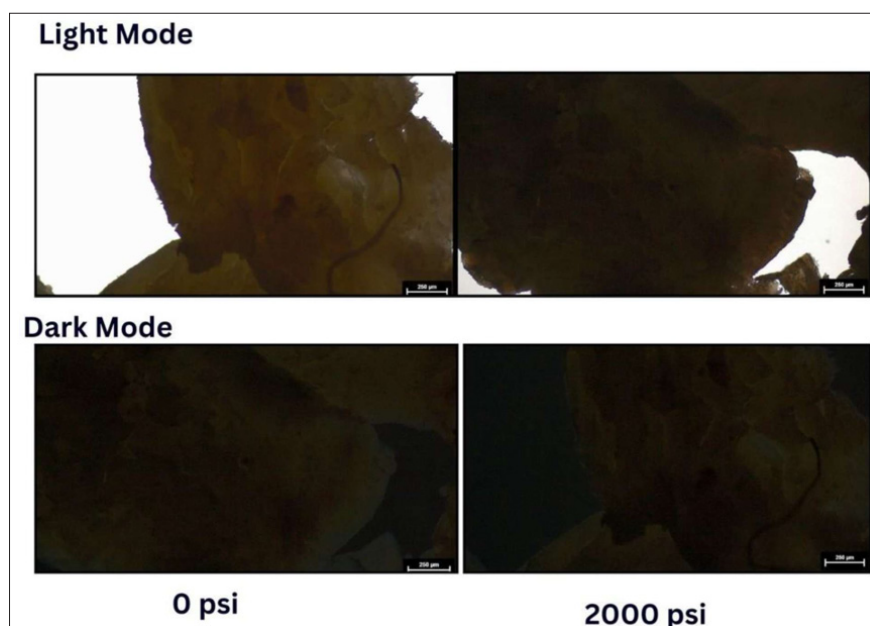


Figure 13: Polarized Microscopy Images of PVC Under Different Pressure Levels

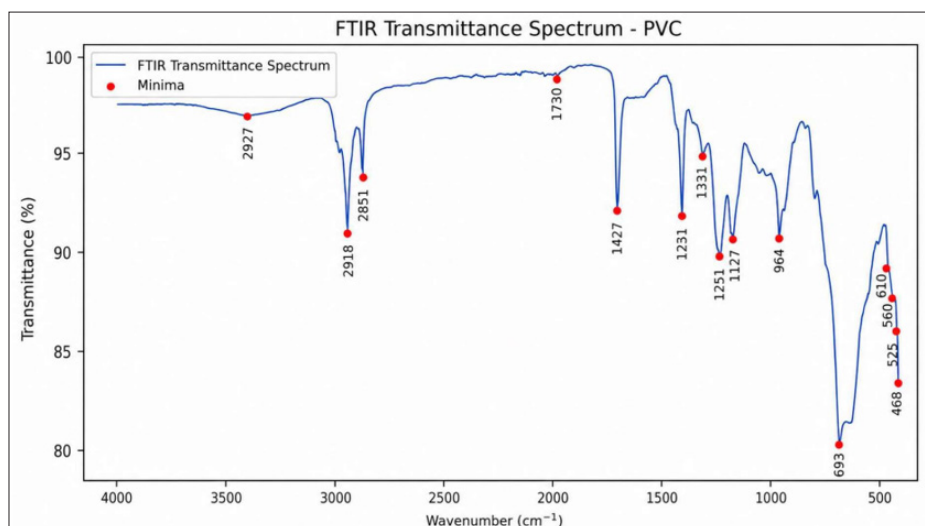


Figure 14: FTIR Peaks of PVC

Polycarbonate (PC)

Polarized microscopic images of PC material without stress and the stress-induced birefringence images under light mode and dark mode are given in Figure 15. It could be noted that this material is revealing a very less intense color in dark mode beyond the 2000 psi level of pressure. The FTIR peaks of the material are given in Figure 16 that matches polycarbonate material.

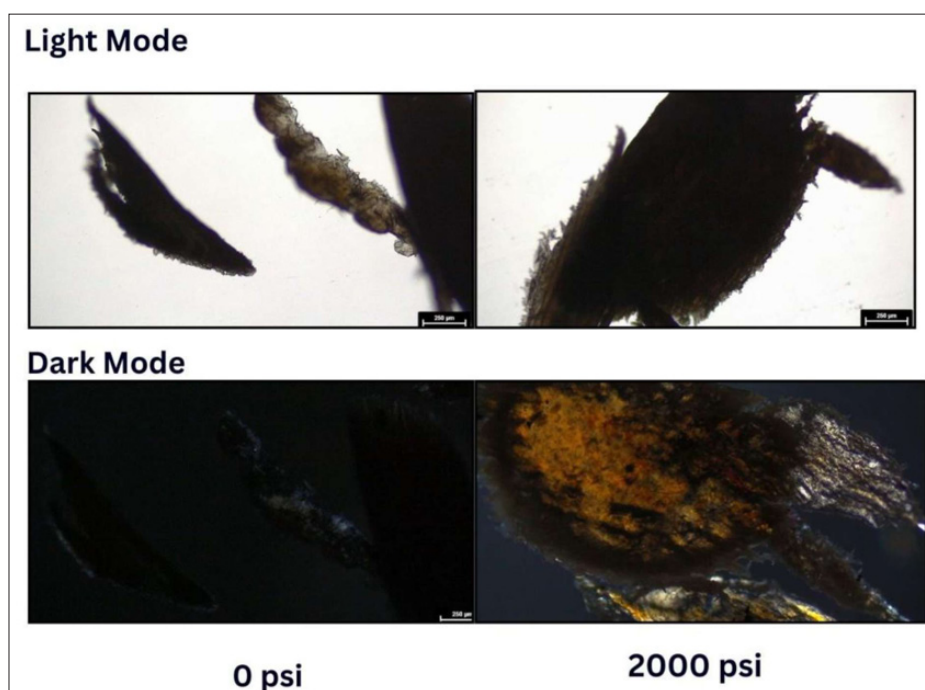


Figure 15: Polarized Microscopy Images of PC Under Different Pressure Levels

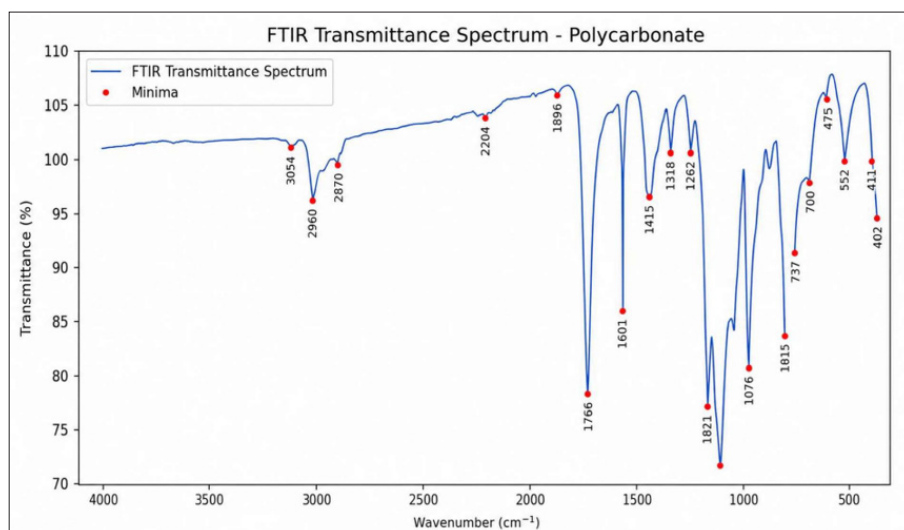


Figure 16: FTIR Peaks of Polycarbonate

Characterization of Microplastics Extracted from Salt

After the extraction, the TSS particles were grouped based on the colour they revealed under the dark mode of the polarized microscope. The IR pattern of each particle has been recorded, and the particles that had matching peaks of plastic materials were examined under the polarized microscope.

Polyethylene in Pink Salt from Maharashtra

The microscopic images of the few extracted particles in light mode and the corresponding dark mode images are given in Figure 17. The colours in dark mode images are metallic silver, brown and blue which is matching with the dark mode images of the standard polyethylene. The IR pattern of the same particles is given in Figure 18. The prominent peaks of FTIR patterns match with the polyethylene. The two sharp peaks 2913 cm^{-1} and 2846 cm^{-1} reveal the C-H stretching mode of vibration, 1470 cm^{-1} and 716 cm^{-1} reveals CH_2 bending and CH_2 rocking respectively. However, the broad peaks at 3379 cm^{-1} may be attributed to moisture content.

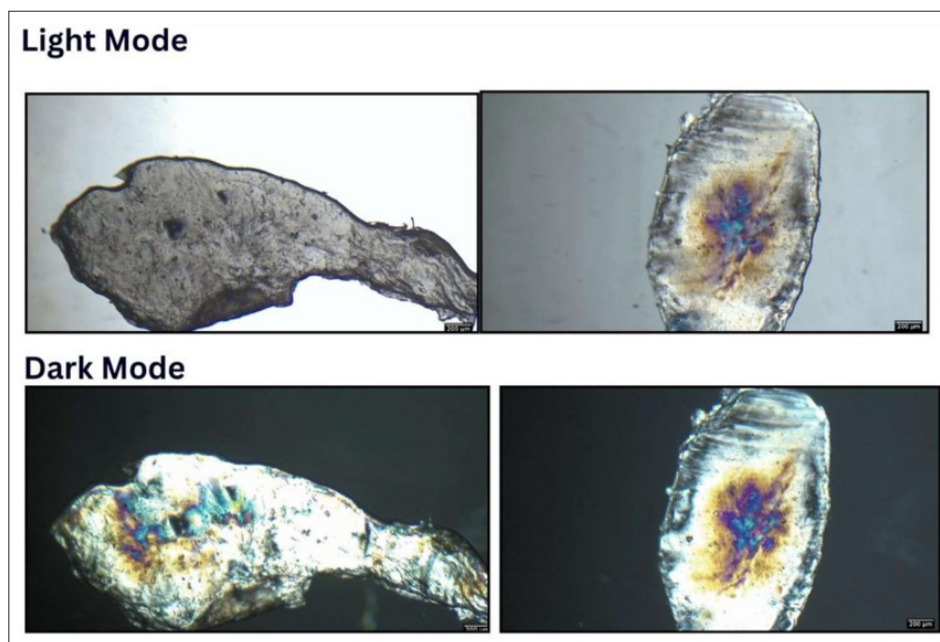


Figure 17: Polarized Microscopy Images of Polyethylene Extracted from Salt

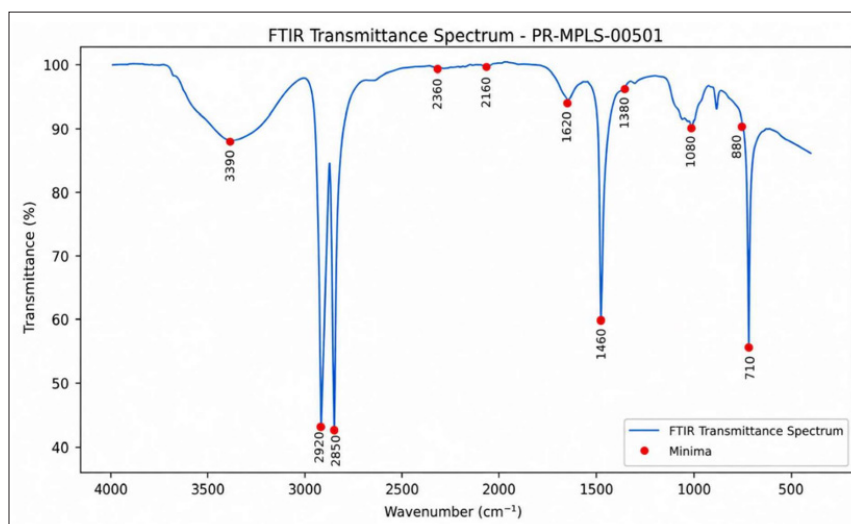


Figure 18: FTIR Pattern of Polyethylene Particles Extracted from Salt

Nylon in Sea Salt from West Bengal

The polarized microscope images of this particle in light mode and dark mode are given in Figure 19. This particle has not revealed any colours under dark mode, so it is expected to have less birefringence as the standard nylon. The IR pattern of the particle is given in Figure 20. A sharp peak at 3272 cm^{-1} reveals N-H stretching, since there are no symmetric stretching it is not a primary amine and another sharp peak at 1625 cm^{-1} belongs to the carbonyl stretching with the linkage of the amide group. Two more sharp peaks at 1515 cm^{-1} and 1235 cm^{-1} may suggest NH bending and C-N stretching. Other peaks at 2922 cm^{-1} reveal CH stretching and 1455 cm^{-1} and 1372 cm^{-1} indicates CH_2 bending. Together, all the peaks indicate the presence of nylon in the sample to corroborate with the microscopic image.

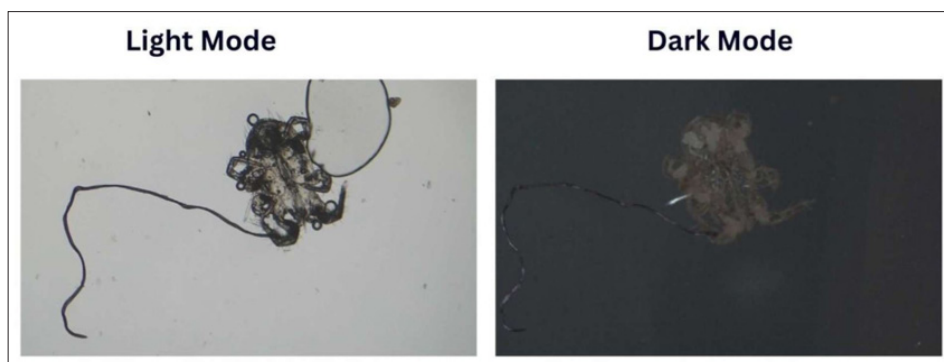


Figure 19: Polarized Microscopy Images of Nylon Extracted from Salt

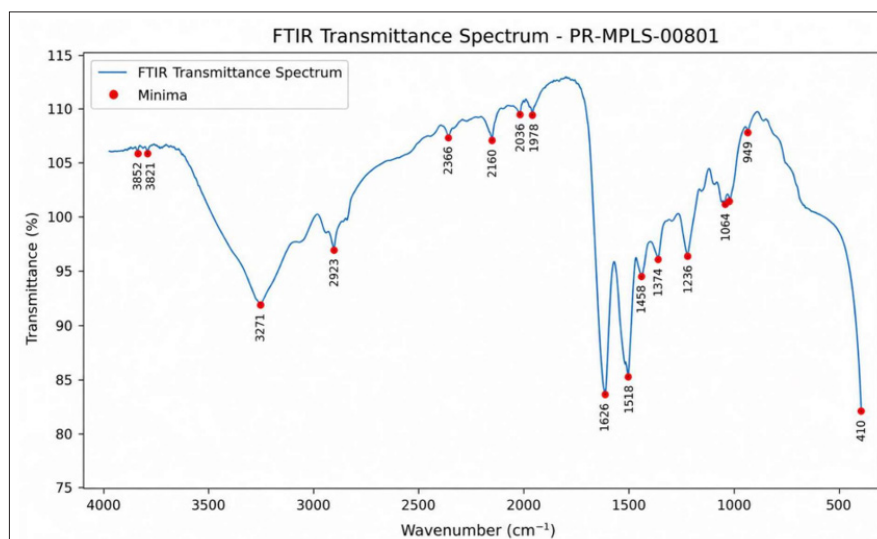


Figure 20: FTIR Peaks of Nylon Particle Extracted from Salt

Mixed Microparticles

Brown Coloured Particles in Pink Salt from Maharashtra

A few particles were revealing the peaks of more than one plastic material; the microscopic images of one of the particles under light mode and dark mode are given in Figure 21. Dark mode images cannot be compared with any of the standard materials, as it is in a mixed state, but this is the first evidence of a new colour revelation of mixed microparticle under dark mode. The FTIR pattern of the same material is given in Figure 22. The presence of 2919 cm^{-1} and 2851 cm^{-1} reveals CH stretching, and 3331 cm^{-1} could be because of N-H stretching (or) O-H stretching, but a weak signal at 1732 cm^{-1} can be attributed to carbonyl stretching. Signals of considerable intensity in the range of 1455 cm^{-1} and a strong signal at 1015 cm^{-1} can be attributed to C-H bending and C-O stretching vibrations. The presence of these many peaks that cannot be attributed to one single type of microplastic therefore makes us to believe that it may be a mixture of plastics and organics.

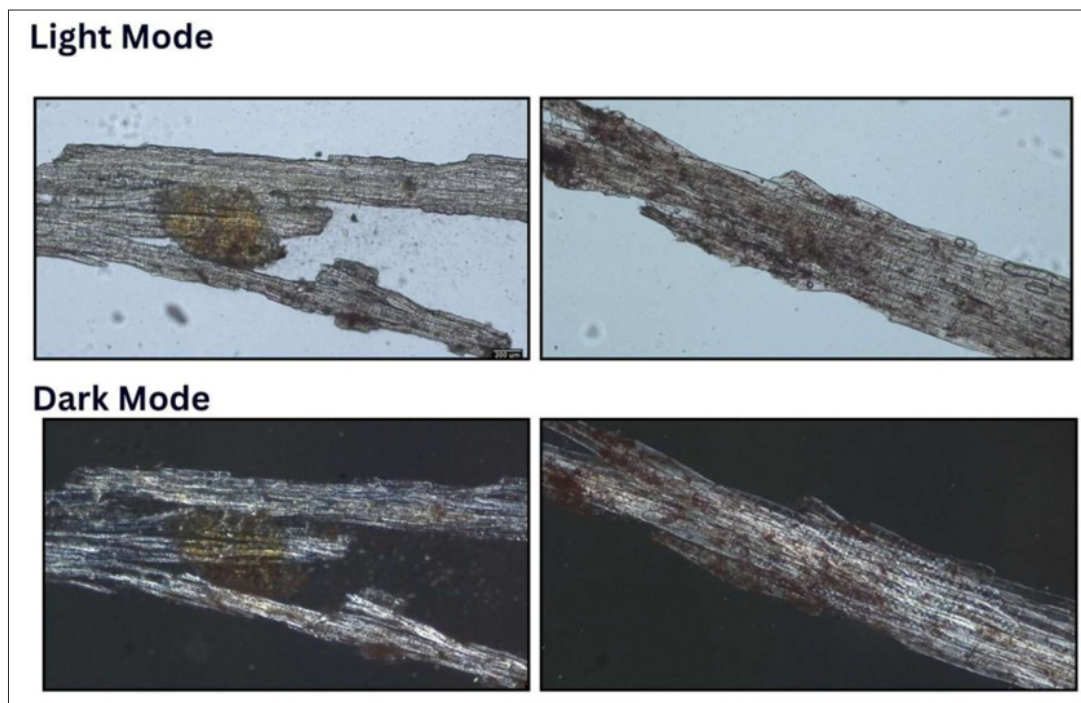


Figure 21: Polarized Microscopy Images of Brown Colored Particles Extracted from Salt

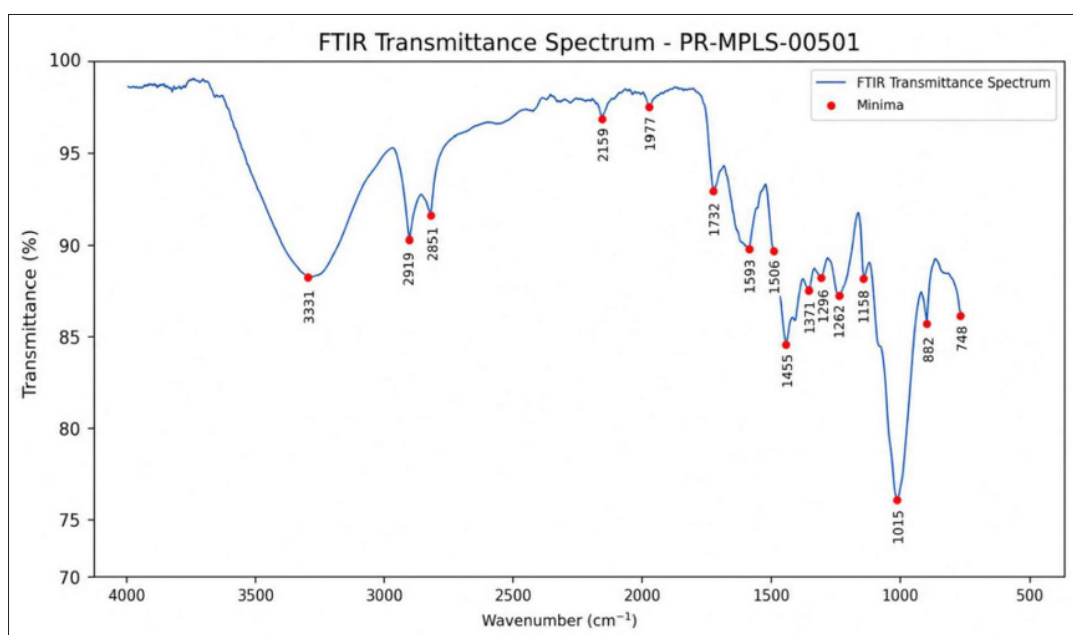


Figure 22: FTIR Peaks of Brown Colored Particles Extracted from Salt

Green Coloured Particles in Pink Salt from Maharashtra

A few kinds of green coloured particles were observed during the separation; the light mode and dark mode images of these particles are given in Figure 23. The FTIR pattern of this particle is given in Figure 24; it reveals that it could also be a mixed microparticle. A sharp peak at 1722 cm^{-1} reveals the carbonyl stretching, and two peaks at 1255 cm^{-1} and 1062 cm^{-1} may suggest C-O stretching of aromatic and aliphatic respectively. This suggests they could be a part of an ester group in the molecule; the double peaks at 2924 cm^{-1} and 2852 cm^{-1} are due to C-H stretching. A non-prominent sharp peak at 711 cm^{-1} could either belong to CH_2 rocking (or) aromatic CH out of plane bending, but the peak is very tiny to consider. So, this microparticle is probably a mixture of cellulosic material and PET.

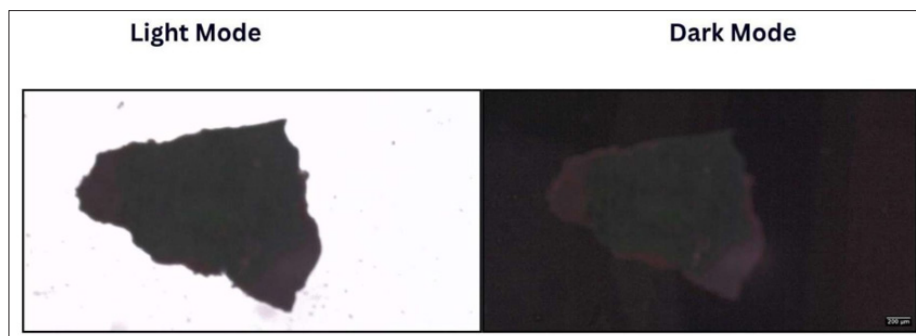


Figure 23: Polarized Microscopy Images of Green Coloured Particles Extracted from Salt

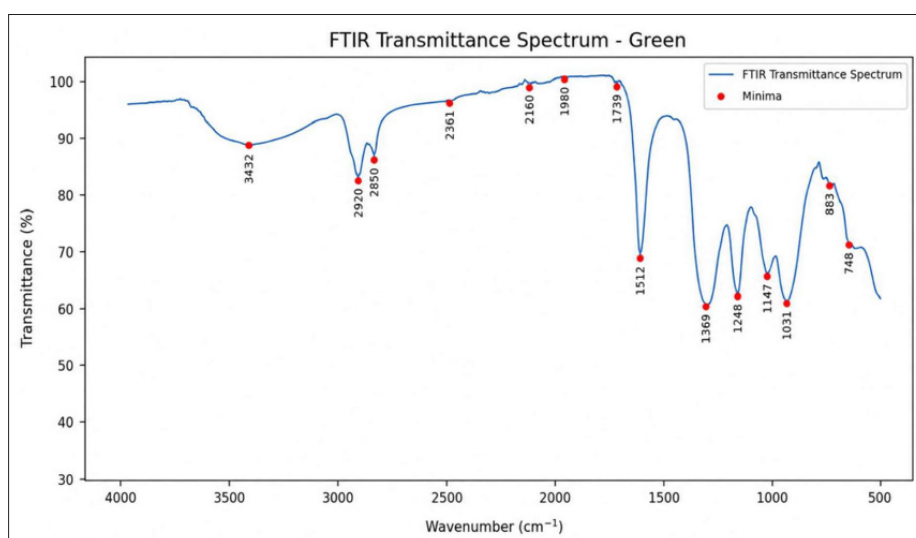


Figure 24: FTIR Peaks of Green Coloured Particles Extracted from Salt

Blue Coloured Particles in Rock Salt from Tamil Nadu

A few blue coloured particles were also observed under which is given in Figure 25. In dark mode also these particles are revealing the same colours. Figure 26 represents the IR pattern of these particles. The prominent peaks in this FTIR pattern matches with multiple particles; three sharp peaks at 3689 cm^{-1} , 3649 cm^{-1} and 3616 cm^{-1} are meant for primary amine, On the other hand, peaks at 1722 cm^{-1} , 1284 cm^{-1} , 1070 cm^{-1} and 721 cm^{-1} reveal that it can also be a PET material. Two sharp peaks at 1028 cm^{-1} and 1006 cm^{-1} suggest that it can also be a cellulosic/carbohydrate type material. So, these particles could be a mixture of organic and plastic material.

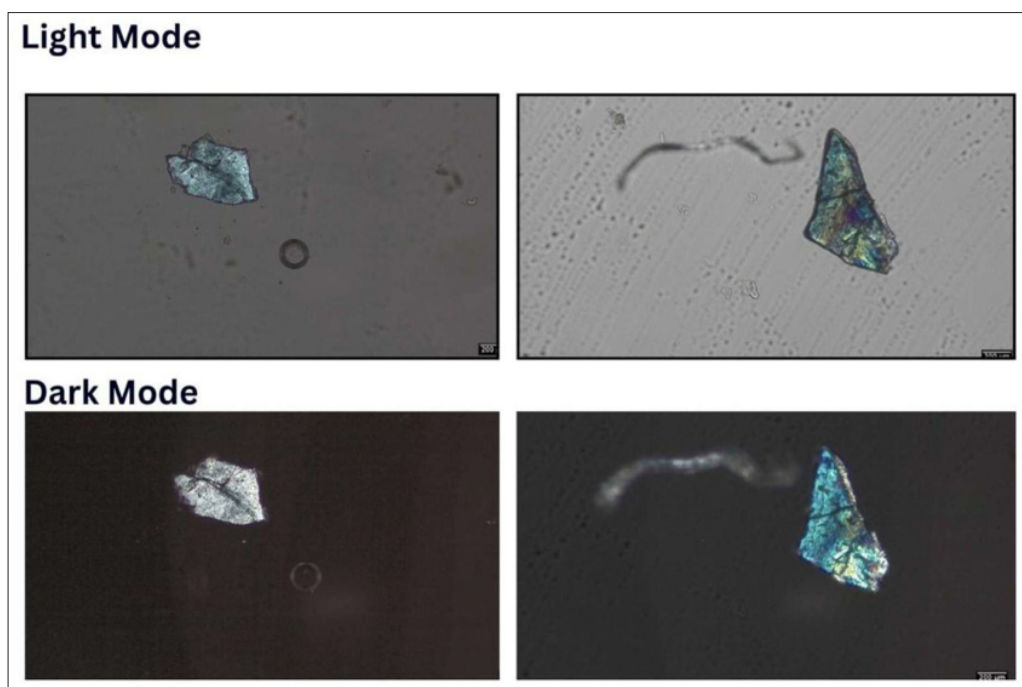


Figure 25: Polarized Microscopy Images of Blue Colored Particles Extracted from Salt Under Light Mode

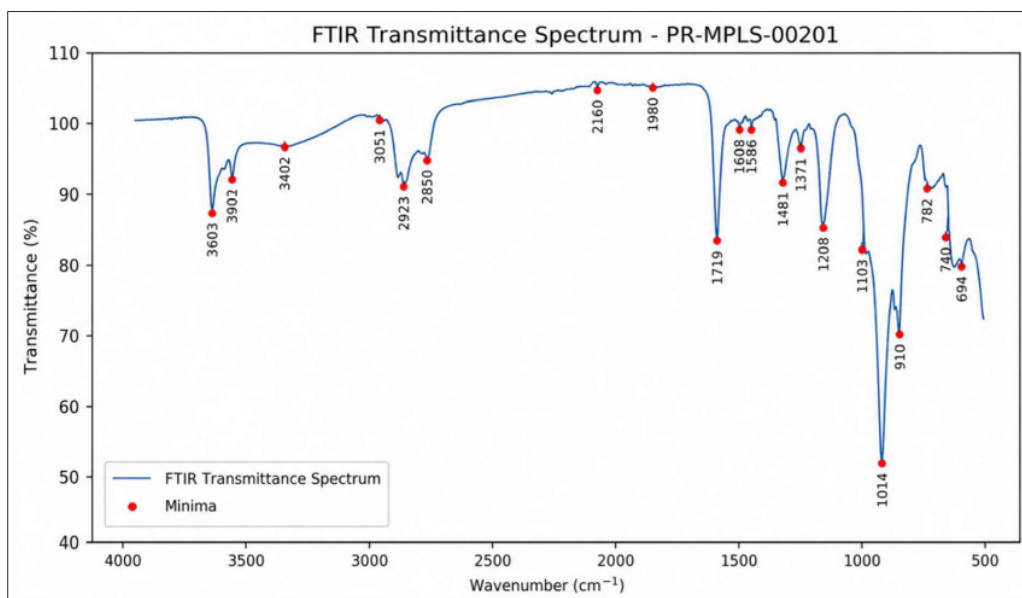


Figure 26: Polarized Microscopy Images of Blue Colored Particles Extracted from Salt Under Dark Mode

Conclusion

In this work, branded commercial salt samples from Bangalore markets have been tested for microplastics. Also, the research gap in using polarization microscopy as a characterization technique for the quantification of microplastics in environmental samples has been addressed. To address this research gap, standard microplastics were prepared from plastic discard materials. Each Microplastic has been subjected to different pressure levels from 0psi to 2000psi; a few colors were dominant in HDPE, LDPE, PP and PET; there were no colors in PVC and Nylon which revealed the non-birefringent nature of those microplastics. A light brown color has been noticed in polycarbonate material at the pressure level of 2000psi. Polycarbonate is expected to have less birefringence. While differentiating the microplastics

from other organic contaminants showing birefringence has been challenging, the behavior of microplastics under different pressure conditions has been captured. Accurate prediction of birefringence, retardance, and sign of elongation along with the images of different plastic materials would help to address this issue. Seven branded salt samples have been purchased from the market which includes sea salt, rock salt, and Himalayan pink salts. Among them, pink salts were found to have more TSS particles; two brands of sea salts, one brand of rock, and one more brand of pink salt were found to be abundant in microplastics. The prominent microplastics in these samples are PE, nylon, and mixture of PET and cellulosic type materials. Polyethylene particles revealed the same colors as standards under dark mode of the polarized microscope; Nylon particles were not revealing

any colors which match the standards. Polarized microscopes would be a promising technique in characterizing microplastics of PE, PP, and PET because of their birefringence nature. The probability of characterizing PVC, PC, and Nylon under this technique is very little significant because of the non-birefringence nature of the particles.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Generative AI and AI-Assisted Technologies in the Manuscript Preparation Process

During the preparation of this work, the authors used chat gpt, gpt 5.5 and QuillBot in order to collect some literature, to remove noise peaks in FTIR and grammatical checks. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Acknowledgments

We express our sincere gratitude to Prayoga Institute of Education Research for supporting this research. We also extend our sincere thanks to sponsors of the Anveshana program including Zerodha, SBI foundation, Motherson-CIM Tools Private Limited, Deloitte Foundation.

References

1. Thompson Richard C, Ylva Olsen, Richard Mitchell P, Anthony Davis, Steven Rowland J, et al. (2004) Lost at sea: where is all the plastic?. *Science* 304: 838-838.
2. Ragusa Antonio, Svelato Alessandro, Santacroce Criselda, Catalano Piera, Notarstefano Valentina, et al. (2021) Plasticenta: First evidence of microplastics in human placenta. *Environment international* 146: 106274.
3. Leslie Heather A, Velzen Martin Van JM, Brandsma Sicco H, Vethaak Dick A, Lamoree Marja H, et al. (2022) Discovery and quantification of plastic particle pollution in human blood. *Environment international* 163: 107199.
4. Nihart Alexander J, Garcia Marcus A, Hayek Eliane El, Liu Rui, Olewine Marian, et al. (2025) Bioaccumulation of microplastics in decedent human brains. *Nature medicine* 31: 1114-1119.
5. Campanale Claudia, Massarelli Carmine, Savino Ilaria, Locaputo Vito, Uricchio Vito Felice, et al. (2020) A detailed review study on potential effects of microplastics and additives of concern on human health. *International journal of environmental research and public health* 17: 1212.
6. Yang Dongqi, Shi Huahong, Li Lan, Li Jiana, Jabeen Khalida, et al. (2015) Microplastic pollution in table salts from China. *Environmental science & technology* 49: 13622-13627.
7. Iñiguez Maria E, Juan A Conesa, Andres Fullana (2017) Microplastics in Spanish table salt. *Scientific reports* 7: 8620.
8. Karami Ali, Golieskardi Abolfazl, Choo Cheng Keong, Larat Vincent, Galloway Tamara S, et al. (2017) The presence of microplastics in commercial salts from different countries. *Scientific reports* 7: 46173.
9. Kim JS, Lee HJ, Kim SK, Kim HJ (2018) Global Pattern of Microplastics (MPs) in Commercial Food-Grade Salts: Sea Salt as an Indicator of Seawater MP Pollution. *Environ Sci Technol* 52: 12819-12828.
10. Ren Monia, Andrea Blašković (2018) Litter & microplastics features in table salts from marine origin: Italian versus Croatian brands. *Marine pollution bulletin* 135: 62-68.
11. Renzi Monia, Grazioli Eleonora, Bertacchini Eleonora, Andrea Blašković (2019) Microparticles in table salt: levels and chemical composition of the smallest dimensional fraction. *Journal of Marine Science and Engineering* 7: 310.
12. Lee Hyemi, Kunz Alexander, Shim Won Joon, Bruno A Walther (2019) Microplastic contamination of table salts from Taiwan, including a global review. *Scientific reports* 9: 10145.
13. Gündoğdu Sedat Contamination of table salts from Turkey with microplastics. *Food Additives & Contaminants* 35: 1006-1014.
14. Kapukotuwa RWMGK, Jayasena N, Weerakoon KC, Abayasekara CL, Rajakaruna RS, et al. (2022) High levels of microplastics in commercial salt and industrial salterns in Sri Lanka. *Marine pollution bulletin* 174: 113239.
15. Parvin Fahmida, Nath Jayasree, Hannan Tamanna, Tareq Shafi M (2022) Proliferation of microplastics in commercial sea salts from the world longest sea beach of Bangladesh. *Environmental Advances* 7: 100173.
16. Seth Chandan Krishna, Amritanshu Shrivastav (2018) Contamination of Indian sea salts with microplastics and a potential prevention strategy. *Environmental Science and Pollution Research* 25: 30122-30131.
17. Sathish Narmatha M, Immaculate Jeyasanta, Jamila Patterson (2020) Microplastics in salt of Tuticorin, southeast coast of India. *Archives of Environmental Contamination and Toxicology* 79: 111-121.
18. Vidyasakar A, Krishnakumar S, Kumar Suresh K, Neelavannan K, Anbalagan S, et al. (2021) Microplastic contamination in edible sea salt from the largest salt-producing states of India. *Marine Pollution Bulletin* 171: 112728.
19. Sivagami M, Selvambigai M, Devan U, Karmegam N, Biruntha M, et al. (2021) Extraction of microplastics from commonly used sea salts in India and their toxicological evaluation. *Chemosphere* 263: 128181.
20. Manimozhi Nagarajan, Rani V, Sudhan C, Manimekalai D, Shalini R, et al. (2022) Spatiotemporal occurrence, distribution, and characterization of microplastics in salt pans of the coastal region of the Gulf of Mannar, southeast coast of India. *Regional Studies in Marine Science* 53: 102350.
21. Zhu Yanmin, Li Yuxing, Huang Jianqing, Zhang Yunping, Ho Yuen Wa, et al. (2024) Advanced optical imaging technologies for microplastics identification: progress and challenges. *Advanced Photonics Research* 5: 2400038.
22. Osborne Amy O, Andrew Jackson RW, Claire Gwinnett (2023) Did We Detect All the Microplastics? The Value of Including Polarized Light Microscopy in the Search Process. SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4482444.
23. Samuel Erdogan Identifying Microplastics and Microfibers in Environmental Samples from Quantitative Material Birefringence Properties. <https://www.hajim.rochester.edu/senior-design-day/identifying-microplastics-and-microfibers-in-environmental-samples-from-quantitative-material-birefringence-properties/>.
24. Sierra Ignacio, Chialanza Mauricio Rodríguez, Faccio Ricardo, Carrizo Daniel, Fornaro Laura, et al. (2020) Identification of microplastics in wastewater samples by means of polarized light optical microscopy. *Environmental Science and Pollution Research* 27: 7409-7419.
25. Liu Tong, Yu Shijun, Zhu Xiaoshan, Liao Ran, Zhuo Zepeng, et al. (2021) In-situ detection method for microplastics in water by polarized light scattering. *Frontiers in Marine Science* 8: 739683.
26. Lusher Amy L, Bråte Inger Lise N, Munno Keenan, Hurley Rachel R, Welden Natalie A, et al. (2020) Is it or isn't

- it: the importance of visual classification in microplastic characterization. *Applied spectroscopy* 74: 1139-1153.
27. Rajan P, Kyatanahalli SN (2024) Detection of Adulteration in Besan (Cicer Arietinum) Using Microscopic Technique. *American Journal of Food Science and Technology* 3: 107-130.
28. Veerasingam S, Ranjani M, Venkatachalapathy R, Bagaev Andrei, Mukhanov Vladimir, et al. (2021) Contributions of Fourier transform infrared spectroscopy in microplastic pollution research: A review. *Critical Reviews in Environmental Science and Technology* 51: 2681-743.

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