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SPECTROSCOPIC ASSESSMENT OF THE SHOE POLISHES PRODUCED FROM WASTE PET BOTTLES AND PURE WATER SACHETS

Lawrence Ekebafe*, Adetoun Akitoye, Chukwuemeka Isanbor and Wesley Okiei
Department of Chemistry, University of Lagos, Akoka, Lagos State, Nigeria
***Corresponding author: lekebafe@unilag.edu.ng**

ABSTRACT

The indiscriminate disposal of plastic waste, particularly used low density polyethylene (LDPE) water sachets and polyethylene terephthalates (PET) bottles, has become a major environmental concern in Lagos, Nigeria. This study explores the conversion of these waste materials into value-added products through pyrolysis for the production of solid and liquid shoe polishes. Pyrolysis was carried out at temperatures ranging from 150°C to 350°C to obtain wax suitable for polish formulation. The physical and chemical properties of the waxes and formulated polishes were characterised using FTIR, SEM, and TGA techniques. Results showed that the polishes exhibited desirable qualities such as soft texture, dark hue, good gloss, wrinkle resistance, and comparable melting point, density, and viscosity to commercial shoe polishes. Sample B (PET-LDPE blend) demonstrated superior performance. This approach not only offers an effective waste management strategy but also supports economic empowerment by enabling small-scale production without the need for costly equipment or chemicals. The study highlights the potential of converting common plastic wastes into commercially viable daily needs products and recommends further exploration of other polyethylene waste types for similar applications.

Keywords: LDPE, water sachets, PET bottles, shoe polish, waste conversion.

INTRODUCTION

Plastic waste production and consumption are increasing at an alarming rate, driven by the growth in the human population, rapid economic development, continuous urbanisation, and lifestyle changes. There is a yearly increase in global plastic production, which is estimated to be approximately 300 million tons per year (Miandad *et al*., 2016; Ratnasari *et al*., 2017). Plastics are composed of petrochemical hydrocarbons and various additives such as flame retardants, stabilisers, and oxidants, which render them resistant to biodegradation (Ratnasari *et al*., 2017). Although waste plastic can be recycled in diverse ways, open dumping or landfill disposal remains the most common practice in developing countries (Gandidi *et al*., 2018). The accumulation of plastic waste in landfills creates breeding grounds for insects and rodents, potentially facilitating the spread of various diseases (Alexandra, 2012). Furthermore, the costs associated with transportation, labour, and maintenance can escalate the overall expenditure of recycling initiatives (Gandidi *et al*., 2018). Mounting environmental concerns regarding waste management in urban centres have intensified efforts to explore alternative valorisation strategies for plastic waste, aimed at producing value-added products such as shoe polish, biochemicals, fuel oil, and energy, sustainable and reusable substitutes for traditionally synthetic and petroleum-based materials (Mohanty *et al*., 2005). This day, nearly every individual around the globe comes into daily contact with plastics. Plastics have become ubiquitous and serve as the backbone of modern economies. However, despite their numerous benefits, the demerits of the current plastics economy are becoming increasingly evident; hence, the innovative approach to convert these to an "everyday" commodity shoe polish.

In Africa, the demand for shoe polish has consistently been on the rise due to population growth, necessitating substantial importation to meet local needs. Shoe polish is a colloidal substance used to enhance the appearance of footwear. It consists primarily of waxes and solvents and is available in different colours. Used water sachets, popularly called "pure water sachet" in Lagos, Nigeria, is made up of Low- Density Polyethylene (LDPE), which has an exceptional resistance to water and is glossy, soft, waxy, and smooth to the touch compared to High-Density Polyethylene. Upon usage and disposal, it accumulates in the environment, blocking drains, causing erosion and subsequently flooding. Due to its waxy nature and ease of processing, it is preferable to utilise LDPE rather than HDPE for formulating shoe polish. Beyond footwear, shoe polish is also applied to other leather goods such as bags. However, recent formulations combine natural waxes and oils alongside petroleum-based components and synthetic polymers (Achankeng, 2003; Akpovi, 1993). Although used water sachet polyethylene can be recycled into useful products such as grocery bags, shampoo bottles, toys, footwear, etc. however, many of these recycled products, being non- biodegradable, will eventually lead to subsequent environmental disposal problems (Owolabi, 2010). Therefore, using LDPE as a raw material for the production of shoe polish using pyrolysis is a more efficient way to manage waste. Solving the challenges of municipal solid waste and plastic waste management in developing countries is fundamental to achieving the Sustainable Development Goals (SDGs). The SDG-related benefits of utilising plastic waste as an alternative material and energy source include reduced dependence on wood and fossil fuels, along with lower labour demands, reduced costs, minimised time expenditure, and decreased risks associated with wood collection.

The objective of this study was to develop a sustainable, cost-effective approach for converting plastic waste into value-added products such as shoe polish.

METHODOLOGY

Materials

The following chemicals and materials were used in this study: stearic acid, turpentine, paraffin oil, fragrance, and colourant. These were purchased from Sigma-Aldrich, Germany. Waste polyethene terephthalate (PET) bottles and pure water sachets were sourced from designated plastic waste dumpsites in Lagos State, Nigeria. Paraffin wax, white beeswax and black/brown pigments and commercial shoe polish (as standard) were purchased from local merchandise stores in Lagos, Nigeria.

Preparation of waste PET bottles and Used Water Sachets

The collected waste PET bottles and used water sachets were first stripped of labels, then washed thoroughly with water and detergent to remove dust and debris, and subsequently sun-dried. The clean plastics were cut into smaller pieces and shredded using a laboratory-grade plastic shredder. The shredded material was sieved using a 4.75 mm mesh sieve (No. 5 ASTM sieve). Particles retained above the mesh were reprocessed by regrinding.

Proximate analysis of used PET bottles and water Sachets (Waste materials)

Ash Content Determination

Approximately 1.0 g of dried PET and pure water sachet samples were weighed to the nearest 0.1 mg and transferred into pre-weighed crucibles. The samples were incinerated in a muffle furnace at 725°C for 1 hour and 30 minutes, after which they were cooled in a desiccator and weighed again.

The percentage ash content (AC %) was calculated using Equation 1:

$$\%\ \mathrm{AC} = \frac{(\text{Mass of crucible} + \text{ash})\ -\ (\text{Mass of empty crucible}))}{(\text{Mass of crucible} + \text{drysample}) - (\text{Mass empty crucible}))}\text{x100} \qquad \textbf{eqn 1}$$

Volatile Matter Content Determination

The muffle furnace was first preheated and the temperature was raised and maintained at 800°C. Empty crucibles were weighed, and approximately 1.0 g of each sample was placed inside. The crucibles were heated for 8 minutes, then cooled in a desiccator and reweighed afterwards.

Volatile matter content (VD, %) was calculated on a dry basis using Equation 2:

$$\mathrm{VD} = \frac{100 \times (B - F) - M_C \times (B - \mathrm{G})}{(B - \mathrm{G}) \times (100 - M_C)} \qquad \textbf{eqn 2}$$

Where: B=mass in g of the crucible and sample before heating; F= mass in g of the crucible and contents after heating; G= mass in g of the empty crucible; Mc= % of moisture content.

Fixed Carbon Content Determination

The fixed carbon content was determined by subtracting the sum of the percentage compositions of the moisture content, volatile matter content, and ash content from 100.

i.e

FCC=100- [MC+VD+AC]

Where:

FCC= Fixed Carbon Content

MC= Moisture Content

VD= Volatile matter Content

AC= Ash Content

Preparation of Polyethylene wax

Different proportions of stearic acid, shredded PET, and polyethylene from sachets were tested to determine the optimal ratio, which was found to be 10:2:5 (10 g stearic acid, 2 g polyethylene, 5 g PET). The mixture was heated using a sand bath at three pyrolysis temperatures: 200°C, 350°C, and 500°C, for 30 and 60 minutes each.

Characterisation of wax

Standard Test Method for Melting Point of Wax

About 3 g of wax sample was placed in a dish on an electric heater. A thermometer was inserted to monitor the temperature. The setup was done in an air bath, supported in position over a water bath, filled with water to within 13 mm (1⁄2 in.) in which temperature was maintained at 16–28°C, and the wax was heated to at least 8°C above its expected melting point (70–90°C). The melting point was recorded using the thermometer.

Density determination of wax by Measuring Cylinder

About 3 g of wax was put into a beaker and weighed, and transferred into a graduated cylinder containing water. The base of the graduated cylinder was fastened on top of a flat surface using tape. When a consistent difference for the liquid displacement was obtained, this was noted, and the volume change was recorded.

Preparation of Solid Shoe polishes from Polyethylene wax

Stearic acid (10 g) was placed in a batch pyrolytic reactor at a controlled temperature (about 120°C). Upon melting, the plastic components (washed, dried and shredded PET bottles (2 g) and used water sachets (5 g PET)) were combined and added into the melting liquid and stirred continuously. Subsequently, paraffin oil, turpentine, and colour pigments were added with continuous stirring to ensure a homogeneous mixture. The molten mixture was poured into moulds and allowed to cool and solidify.

Shoe Polish Formulations and their Mixing Ratio

Two distinct polish formulations were prepared and categorised based on pyrolysis temperatures. Sample A is shoe polish made using polyethylene wax derived from used water sachets (150°C); While Sample B is shoe polish made using polyethylene wax derived from used water sachets and PET bottles (200°C). The density, melting point, and viscosity of the prepared polishes were determined and compared with a commercial standard (Sample C) using ASTM standard methods.

Table 1: Shoe polish formulation

INGREDIENTS	SAMPLE A (g)	SAMPLE B (g)
PE Wax and PET wax	7	7
Paraffin wax	25	20
Stearic wax	10	10
Fragrance	8	8
Turpentine	35	35
Color	2	2

Characterisation of Shoe Polishes

Viscosity Determination by Rotary Viscometer Method

The viscosity of the shoe polishes produced was determined using a rotational viscometer, as described by the Brookfield method (ASTM D2983), (Howard, 2001). In this method, a sample of the polish was placed in a glass tube housed within an insulated heating block maintained at a controlled temperature. A metal spindle was immersed in the sample and rotated at a fixed speed of 10 rpm, while the torque required to maintain rotation was recorded. The measured torque, corresponding to the internal shear resistance of the polish, was used to calculate its absolute viscosity, expressed in centipoise (cP). pH Determination was done as follows: 2g of the shoe polish was diluted with 50ml distilled water to create a solution suitable for pH measurement. The pH meter electrode was immersed into the prepared shoe polish sample and allowed the reading to stabilise. The pH value displayed on the meter was recorded. Similar to pH, the polish was mixed with distilled water to create a workable solution for conductivity measurement.

Evaluation of the Performance of Shoe Polishes

The performance of the shoe polishes was assessed by applying them to leather substrates and physical properties were evaluated as follows:

•**Gloss/Lustre:** The visual appearance of the polished leather was assessed for its brightness and reflectivity under ambient light conditions (ASTM E284, 2002).

•**Rub Resistance:** The durability of the polish against mechanical abrasion was evaluated by rubbing the polished surface 40 times using clean, white cotton fabric. The extent of colour removal and staining on the cloth was used as a qualitative indicator of rub resistance (BS EN ISO 11640, 2019).

•**Fading Resistance:** The resistance of the polish to photodegradation was assessed by exposing the polished leather samples to direct sunlight for 74 hours. Changes in colour tone and loss of gloss were recorded (Boer,*et al*, 2005)

•**Dust Absorption Resistance:** To simulate environmental exposure, the polished samples were left in an open, dust-prone environment for 24 hours. The extent of dust adhesion on the surface was visually examined and recorded (Li, et., al, 2007).

•**Wrinkle/Crease Resistance:** The mechanical integrity of the polish film was evaluated by creasing the polished leather (Kandolph, 2007). Each leather polished with samples A and B was held at both ends and flexed to simulate wear-and-tear. The test assessed whether the polish film peeled, cracked, or remained intact during the process.

Spectroscopic Analysis of the Shoe Polishes

Fourier Transform Infrared (FTIR) Spectroscopic Analysis:

FTIR analysis was conducted using a Cary 630 spectrometer (Agilent Technologies) within the spectral range of 4000–650 cm^{-1}. This allowed for the identification of functional groups and chemical bonding characteristics, confirming the presence of polymeric and organic compounds within the shoe polish matrix (Barth, 2007).

Scanning Electron Microscopic (SEM) Analysis:

The surface morphology and microstructural features of the shoe polish samples were examined using a Phenom ProX SEM (Model 800-07334, Phenom-World B.V). Samples were mounted on carbon adhesive tapes and observed at an accelerating voltage of 30 kV, providing detailed insights into particle distribution, homogeneity, and surface texture (Thermo Fisher Scientific Phenom-World BV, 2017).

Thermogravimetric Analysis (TGA):

Thermal stability and degradation behaviour of the shoe polish formulations were analysed using TGA. Samples were heated from 30°C to 660°C at a controlled heating rate of 10°C/min, and the percentage weight loss was plotted against temperature. This allowed for the identification of thermal decomposition stages, which is critical in understanding the stability of the polish formulations (Jayadas, 2005).

RESULTS AND DISCUSSION

Results of the Proximate Analysis of used PET Bottles and LDPE Water Sachets

The results of the proximate analysis of the waste PET bottles and used water sachets are presented in Table 2. As shown, the fixed carbon content of the PET bottles (11.80%) was significantly higher than that of the used water sachets (5.05%). This difference can be attributed to the higher carbon concentration in the polymer backbone of polyethylene terephthalate (PET), which features aromatic ring structures and a more complex repeating unit than low-density polyethylene (LDPE), the primary constituent of used water sachets (Salman *et al*, 2021). Conversely, the volatile matter content was found to be higher in the used water sachets (99.25%) compared to the PET bottles (87.95%). This is likely due to the greater release of reductive gases such as H_2, CH_4, and minor amounts of CO and elemental carbon during pyrolysis, as reported by Murana *et al*. (2020). The ash content for both samples was negligibly low, indicating minimal inorganic residue after combustion. Furthermore, no measurable moisture content was detected in either sample, suggesting that both plastic waste materials were effectively dried prior to analysis.

Table 2: Proximate Analysis of used PET Bottles and used Water Sachets

Parameters Analyzed	LDPE Water Sachet	PET Bottles
Ash Content (%)	0.20	0.05
Moisture Content (%)	0.0	0.0
Volatile Matter Content (%)	99.25	87.95
Fixed carbon Content (%)	5.05	11.80

Results of the Properties of Wax Produced from waste PET Bottles

Effect of Pyrolysis Temperature and Time on Wax Yield

The influence of pyrolysis temperature and residence time on the yield of wax derived from waste polyethylene (PE) and polyethylene terephthalate (PET) is presented in Tables 3 and 4. A significant reduction in wax yield was observed at higher pyrolysis temperatures. Specifically, at a pyrolysis temperature range of 150°C–350°C for 30 minutes, the yield ranged between 19.8% and 36.7%, while an extended pyrolysis time of 60 minutes resulted in a markedly reduced yield of 3.7% to 15.4% for both PET bottles and LDPE water sachets. This decline in yield with increasing temperature and time aligns with observations reported by Jixing *et al*. (2003), who noted a similar trend during the pyrolysis of waste plastics for polyethylene wax production. The melting points of the waxes obtained in this study fall within the acceptable range defined by ASTM standards, indicating the functional quality of the produced wax. Notably, when PE wastes were pyrolysed at 150°C, the yield decreased sharply from 3.7% as the pyrolysis time increased to 60 minutes. Two primary factors contribute to the decline in yield with elevated temperatures: (1) increased formation of gaseous products such as methane, ethylene, and hydrogen due to secondary cracking reactions; and (2) vaporisation losses of wax during the transfer from the pyrolysis reactor to the mould (Jixing *et al*., 2003).

Table 3: Parameters of the Synthesised Wax

Process Parameters	Values
Pyrolysis temperature (°C)	350
Melting Point (°C)	110
Density @ room temperature (Kg/m³)	881.5

Table 4: Melting Points at Different Pyrolysis and Yield

Sample No.	Yield of Wax (%)	Pyrolysis Temperature (°C)	Time of Pyrolysis (mins)	Melting Point (°C)
A1	20.8	150	30	105
B1	21.5	150	30	105
A2	28.5	200	30	91
B2	26.4	200	30	94
A3	15.4	150	60	95
B3	11.0	150	60	95
A4	8.9	200	60	83
B4	6.5	200	60	83

The melting point of polyethylene wax is primarily influenced by the molecular weight distribution and the extent of pyrolysis undergone by the waste materials (Abdy et al., 2023). As pyrolysis proceeds, polymer chains break into shorter segments, resulting in a lower molecular weight and consequently a lower melting point. As shown in Table 4, increasing the pyrolysis temperature leads to a progressive decrease in wax melting point. Specifically, for pyrolysis conducted between 150°C - 350°C, the melting point of the wax ranged from 62°C - 106°C. At temperatures below 150°C, the LDPE water sachets were not fully decomposed into wax, hence no measurable melting point could be determined at these lower temperatures. A significant drop in melting point was observed at 200°C, particularly after 30 minutes, indicating a rapid breakdown of polymer chains as pyrolysis intensity increased. These findings are in agreement with the results reported by Jixing *et al*. (2003), who obtained waxes with melting points between 144–104°C from pyrolysed waste plastics. According to Caifu *et al*. (2010), the acceptable melting point range for microcrystalline wax falls within 60–93°C, suggesting that the waxes obtained in this study meet or approach the industry-standard specifications depending on the pyrolysis conditions.

Evaluation of Physical Properties of Shoe Polishes

The physical properties of shoe polishes formulated from waste materials are presented in Table 5. Samples A and B were produced using the previously described formulations. As shown, Sample B exhibited a higher density than Sample A, suggesting better material packing and potential for improved coating behaviour (Gumel, 2006). The viscosity values of the shoe polish Samples A–C and the control are also presented in Table 5. Among the formulations, Sample B showed the highest viscosity, which is attributed to enhanced molecular interactions between the polyethylene-based wax and the other polish constituents. The increased viscosity contributes to a more stable formulation and improved application consistency.

In terms of gloss performance, Sample B displayed superior lustre, likely due to the tinting strength of polyethylene and its effective compatibility with the solvent and oil components (Turner, 1993; Morgans, 1990). Additionally, all samples, including Sample B, demonstrated good rub resistance, retaining colour and sheen after repeated abrasion with cotton material. The fading resistance of the shoe polishes was generally comparable across all samples. Sample B, in particular, maintained gloss and tone after prolonged exposure to sunlight, a behaviour attributed to the smooth surface texture and high tinting capacity of the waste-derived wax (Gumel, 2006). Dust resistance was also notably superior in Sample B, which can be linked to its fine particle size and uniform surface texture, factors known to reduce dust adhesion (Christie, 1993). Finally, all the shoe polishes exhibited excellent wrinkle and crease resistance, a result of the strong interaction between the wax and the formulation components, as well as the firm adhesion to the leather substrate (Guthrie & Lin, 1994).

Table 5: Results of the Characterisation of the Solid Shoe Polish

Parameters	Sample A	Sample B	Sample C (Standard)
Viscosity (Ns/m2)	6.50	7.65	8.11
Luster/Gloss	Good	Very Good	Good
Rub Resistance	Good	Good	Good
Fading Resistance	Very Good	Very Good	Very Good
Dust Absorption Resistance	Good	Very Good	Very Good
Wrinkle/Crease Resistance	Good	Good	Very Good
Density (g/cm3)	0.58	0.64	0.62
Colour	Black	Neutral	Brown
pH	5.8	5.5	6.0
Conductivity (mS/cm) at room temp.	0.98	0.95	0.97

Figure 1: Solid shoe polishes produced

FTIR Characterisation Results of Shoe Polish Samples

In this study, the FTIR spectra of shoe polish samples were analysed to identify the chemical constituents present in each formulation. The representative FTIR spectrum of Sample A is presented in Figure 2, while B is presented in Figure 3.

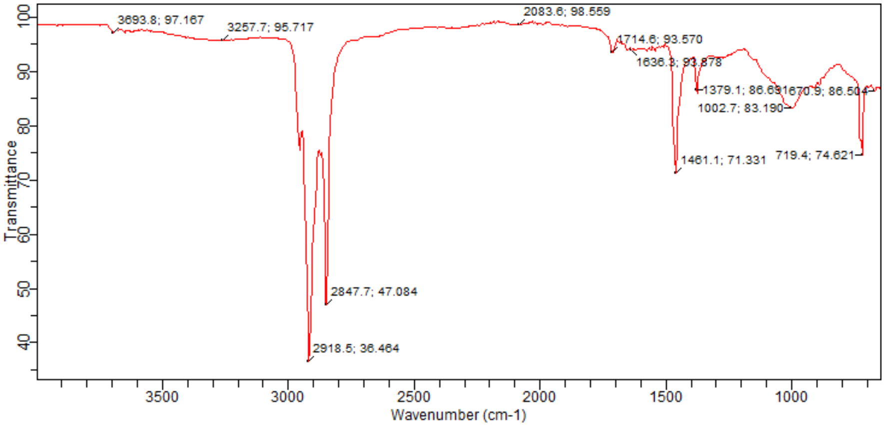

Figure 2: FTIR spectra of shoe polish (Sample A)

Sample A contains peaks indicative of polyethylene wax, e.g., strong peaks at 2900 cm^{-1} which indicate the presence of C-H bonds in the polyethene wax. There is a CH_2 bending at 1460 cm^{-1} and 720 cm^{-1} which further confirms the presence of polyethylene.

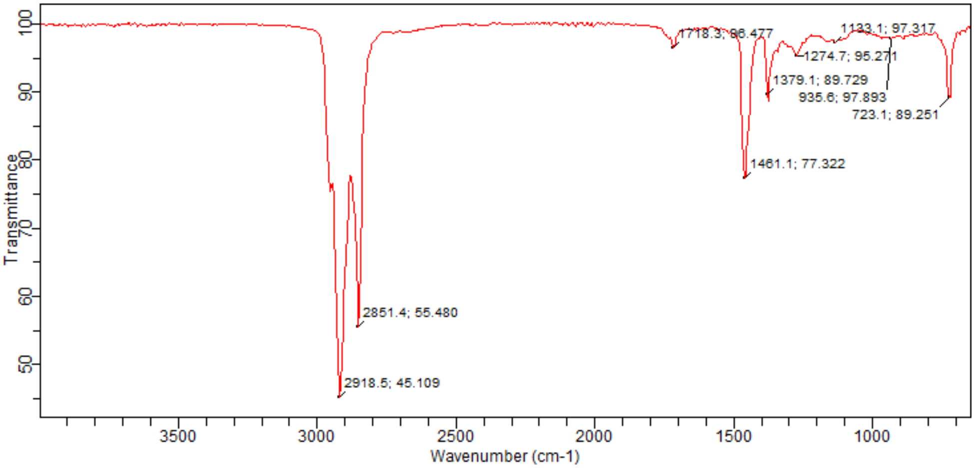

Figure 3: FTIR Spectra of Shoe Polish (Sample B)

Sample B, on the other hand, demonstrated a more complex spectrum with absorption features indicative of both polyethylene and polyethylene terephthalate (PET). Alongside the ~2900 cm^{-1} C–H stretch, Sample B shows a distinct peak at 1710 cm^{-1}, corresponding to C=O stretching vibrations of ester carbonyl groups, and a peak at 1100 cm^{-1}, attributed to C–O stretching. These additional peaks are characteristic of PET-derived materials, implying the presence of terephthalate-based components (Smith, 2018). Peaks at 1460 cm^{-1} and 720 cm^{-1} remain consistent with the presence of polyethylene. Comparatively, both Samples A and B show strong peaks around 2900 cm^{-1}, similar to the control, confirming the presence of polyethylene wax. However, Sample B displays additional functional group peaks (1710 and 1100 cm^{-1}), indicative of PET, which aligns more closely with the spectrum of the commercial polish (Smith, 2018). This suggests that Sample B, due to the incorporation of PET-based components, has a more complex chemical profile and may exhibit performance characteristics similar to commercial products.

SEM Characterisation Results of Shoe Polish Samples

Figure 4 presents the SEM micrograph of the fracture surface of the material composed solely of LDPE, while Figure 5 shows the corresponding micrograph for the LDPE-based composite used in the formulation of the shoe polish. In the case of the non-reinforced LDPE, the fracture surface appears smooth and uniform, indicating the absence of structural defects and confirming the homogeneity of the matrix (Sharma *et al*, 2023).

Similarly, the micrograph of the composite sample reveals a uniform and smooth fracture surface, suggesting a well-dispersed distribution of the incorporated polish components. The shoe polish particles, with an average particle size of approximately 100 µm, are distinctly visible and appear well-embedded within the LDPE matrix, demonstrating strong interfacial adhesion between the polymer and the polish material. This good adhesion may be attributed to the chemical modification of the filler material during the formulation process, which likely contributed to a reduction in the hydrophilic nature of the polish components. (Sharma *et al*, 2023). As a result, compatibility with the hydrophobic LDPE matrix is improved, enhancing the mechanical integrity and uniformity of the final polish.

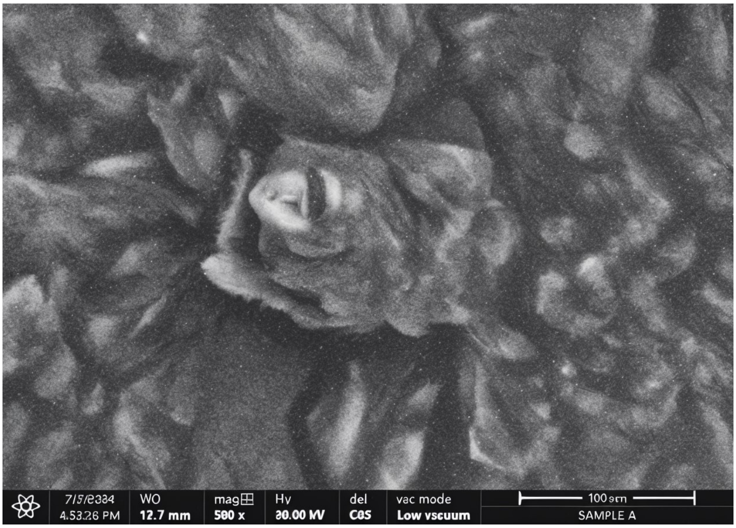

Figure 4: SEM of shoe polish (Sample A) with magnification of x500

Figures 4 and 5 show certain gels and voids in the surface as well as the cross-sectional area of the shoe polish surface in addition to the collagen bundles. This may be as a result of the colloidal formations resulting from the interactions of the shoe formulation components, indicating uneven adhesion between the components of the polish. However, increasing proper stirring for good interaction improved their permeability, bonding, and interfacial-adherence as shown in figure 5. In fact, as demonstrated in Figure 5, the distribution of the polish components was fairly intense.

Additionally, the strong bonding between the polish components shows a remarkably large improvement in the physico-mechanical properties of the shoe polish materials made from the respective formulations.

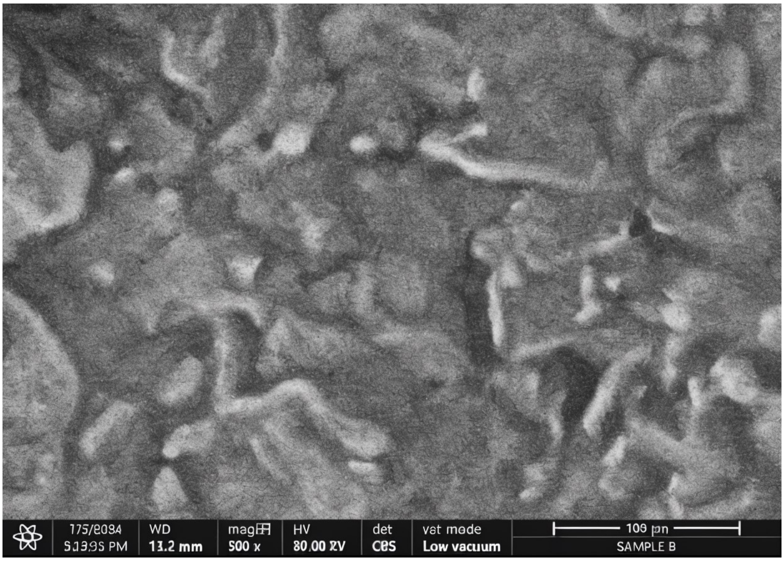

Figure 5: SEM of Shoe Polish (Sample B) with magnification of x500

TGA Characterisation Results of Shoe Polish Samples

The thermogravimetric analysis (TGA) results for the formulated shoe polish samples are presented in Figures 6 and 7. For Sample A, the thermal decomposition began at an Initial Decomposition Temperature (IDT) of 430°C, with the main decomposition range spanning from 430°C to 500°C, and a residual mass of 12.5%. In contrast, Sample B exhibited a higher IDT of 520°C, a main decomposition range between 520°C and 650°C, and a residual mass of 13%.

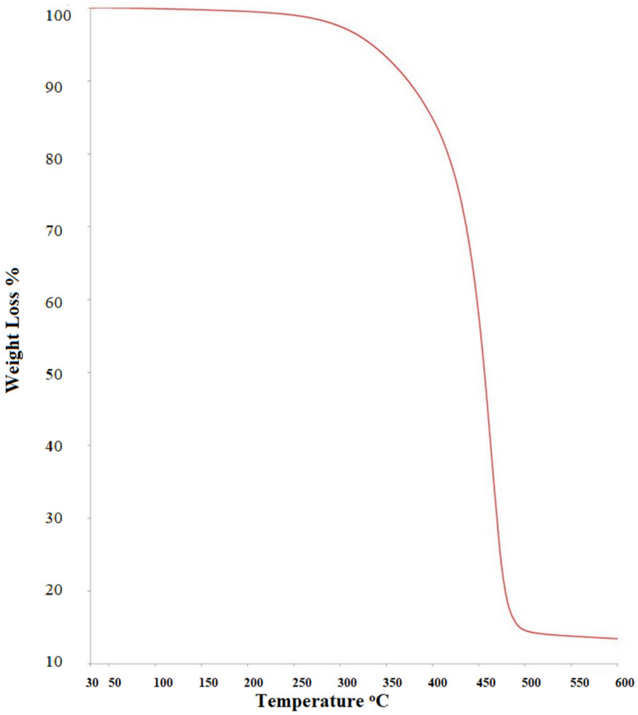

Figure 6: TGA of Shoe Polish (Sample A)

The higher IDT and extended decomposition range observed in both samples indicate that the shoe polishes possess enhanced thermal stability, likely due to the incorporation of thermally stable polymers such as LDPE and PET. The higher thermal onset temperature for Sample B, in particular, suggests greater structural robustness, likely due to the presence of PET, which decomposes at higher temperatures compared to polyethene-based materials(Sharma *et al*, 2023). The relatively low residual mass values (12.5% for Sample A and 13% for Sample B) imply a limited amount of inorganic or non-volatile residue, further indicating that the polishes are primarily composed of organic compounds with efficient thermal degradation.

The slightly higher residue in Sample B may be attributed to the presence of more thermally stable aromatic components from PET degradation (Sharma *et al*, 2023). These TGA results demonstrate that both formulated polishes are thermally resilient, with Sample B exhibiting superior thermal performance, making it potentially more durable in high temperature applications.

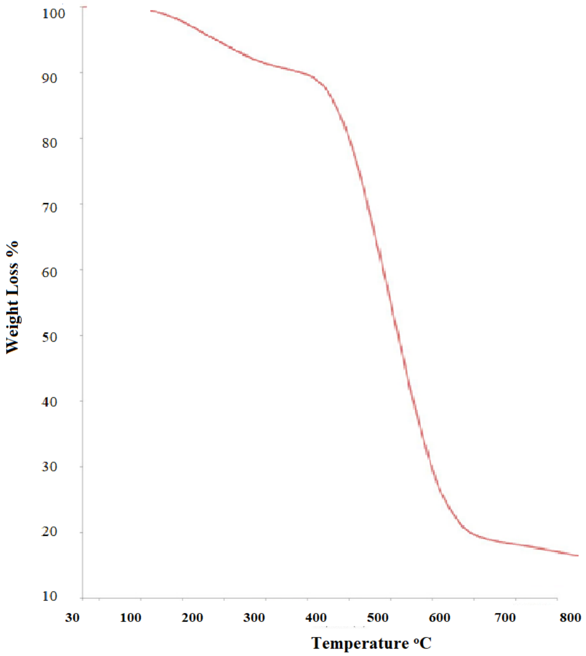

Figure 7: TGA of Shoe Polish (Sample B)

CONCLUSION

Plastic waste has become an increasingly uncontrollable environmental challenge in Lagos, Nigeria, where indiscriminate disposal of polymeric materials, especially LDPE water sachets and PET bottles, has led to widespread pollution and land occupation. This study presents a sustainable and innovative approach to plastic waste management by transforming these pollutants into value-added products, specifically solid and liquid shoe polishes. Through pyrolysis at temperatures between 150°C and 350°C, waste LDPE and PET plastics were successfully converted into waxes suitable for polish formulation. The resulting shoe polishes demonstrated favourable characteristics such as soft texture, dark colouration, high gloss, and excellent wrinkle and dust resistance. The physical properties; melting point, density, and viscosity of the formulated polishes were found to compare favourably with those of standard commercial products, thereby validating the potential of this waste-to-resource approach. In addition to mitigating environmental degradation, this approach holds significant socio-economic benefits. It also promotes public health by reducing the spread of disease associated with plastic litter, while also generating employment opportunities for both skilled and unskilled labour. Importantly, the process is low-cost and scalable, requiring minimal equipment, thus making it accessible for home or community level production. Future research could explore the pyrolytic conversion of other polyethylene waste types into polyethylene wax. This would further expand the scope of sustainable applications and enhance the circular economy by transforming a broader range of polyethylene wastes into high-value materials in support of SDGs 7, 8, 12 and 13.

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