RECYCLING PLASTIC BOTTLES INTO SUSTAINABLE 3D PRINTING FILAMENT AND ELECTRICAL INSULATOR MATERIAL

Project Reference No.: 48S_BE_4484

College : *Angadi Institute Of Technology And Management, Belagaavi*
Branch : *Department Of Electrical And Electronics Engineering*
Guide : *Prof. Vinay Pattanashetti*
Student(S): *Mr. Sandesh A Mantri*
Mr. Shivabasayya Mathad
Mr. Aman Wakilkar
Ms. Deepthi Kurbet

Keywords:

3D printing filament ,Dielectric strength , Eco-friendly materials, Electrical insulator, Filament extrusion, Green manufacturing, LDP(Low density polyethene), PET (Polyethylene Terephthalate), Recycling plastic bottles Sustainable materials, PET (Polyethylene Terephthalate).

Introduction:

Recycling plastic bottles into sustainable 3D printing filament and electrical insulator material presents an innovative solution to two pressing global challenges: plastic pollution and the need for eco-friendly manufacturing resources. Plastic bottles, primarily composed of PET (Polyethylene terephthalate) and LDPE (Low density polyethene), are abundant waste materials that hold great potential for upcycling into valuable products.

This project aims to transform discarded plastic bottles into high-quality 3D printing filament and functional electrical insulators. By leveraging accessible recycling and extrusion technologies, we can create materials suitable for diverse applications, including prototyping, low-voltage electrical components, and sustainable consumer products.

Recycled PET , LDPE -based filaments offer strength, flexibility, and thermal stability, while also serving as effective electrical insulators due to their inherent dielectric properties. With appropriate processing and additive enhancements, these recycled materials can meet both mechanical and electrical performance standards.

Objectives:

- To design and implement a system that converts discarded plastic bottles, primarily made of polyethylene terephthalate (pet) and ldpe (low density polyethene), into high-quality 3d printing filament and low-voltage electrical insulator, thereby promoting recycling, sustainability, and reducing plastic waste

Methodology:

- System Development: Building a prototype system that integrates shredding, extrusion, and quality control using sensors to ensure consistency in filament diameter.
- Experimental Setup: Testing extrusion parameters such as temperature and nozzle design to optimize filament production.
- Material Evaluation: Conducting tensile strength, thermal stability, and strain tests to ensure material quality and reliability.

Experimental set up :

Fig 1 : Side view of project

Fig 2: Inside view without paint

Fig 3: Another side view

Fig 4 : Top view **of project**

Result

1. Filament Production from Recycled LDPE

Meter	Value/Observation
Plastic Source	Recycled LDPE (milk bottles, bags)
Cleaning Process	Washed with detergent, hot water rinse
Shredded Particle Size	4–6 mm flakes
Drying Temperature	60°C for 4 hours
Extrusion Temperature	130°C – 150°C
Filament Diameter Range	1.75 ± 0.08 mm
Filament Consistency	Moderate (80% uniformity)
Extrusion Speed	~1.0 m/min

Note: LDPE is soft and prone to stringing during extrusion and printing. Cooling had to be carefully controlled

2. Mechanical Testing of LDPE Filament

Test	Result
Tensile Strength	8.2 MPa
Young's Modulus	0.2 GPa
Elongation at Break	~100%
Flexural Strength	Low (not ideal for structural parts)

Printability Rating	Fair (requires slower print speed and cooling)

Test Type	Result
Dielectric Strength	~25–30 kV/mm
Breakdown Voltage	~6.5 kV (for 0.25 mm thick sample)
Surface Resistivity	10^{16} ohms/sq
Insulation Class	A (up to 105°C operating temperature)
Performance at 230V AC	No leakage, no surface degradation

Future Scope:

1. Add latest crusher to crush the plastic bottle in tiny particles
2. Add CNC (computer numerical control) devices in project to do automation like 3d printing machine to do accurate shape of insulators