



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 4, April 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

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Manufacturing of 3D Printing Filament Using 3D Waste Material

Mr. Rushikesh Rasal¹, Amey A. Jadhav², Nivrutti A. Mhapadi³, Aniruddha S.Jadhav⁴,

Sairaj S. Mhadeshwar⁵

Assistant Professor, Department of Mechanical Engineering, Finolex Academy of Management and Technology,
Ratnagiri, University of Mumbai, India¹

Students, Department of Mechanical Engineering, Finolex Academy of Management and Technology, Ratnagiri,
University of Mumbai, India^{2,3,4,5}

ABSTRACT: The goal of this research is to create 3D printing filaments from waste filaments. In recent years, the issue of plastic recycling has become one of the most important issues in environmental protection and waste management. Polymer materials are used in many areas of daily life and industry. With their long-term use, the problem of plastic waste arises as they become persistent hazardous waste after they cease to be used. The goal is to shift towards sustainable solution by recycling plastic waste and provide a cost-effective alternative to traditional 3D printing filaments. The process involves shredding and melting plastic waste, extruding the molten plastic into filaments, which are then wound onto spools. Filaments can be made from various waste plastics such as PET, ABS, and PLA. The resulting filaments were then tested for physical properties such as tensile strength, elongation at break, and cut uniformity. The end product meets the quality standards required for 3D printing, with the added benefit of reducing the amount of plastic waste in the environment. This approach offers a viable solution to environmental and economic challenges, turning waste into a valuable resource for the 3D printing industry.

KEYWORDS: Extruder, 3D, PET, PLA, ABS

I. INTRODUCTION

3D printing has revolutionized the way we create products, prototypes, and even body parts. However, as 3D printing becomes more popular, the amount of waste generated from 3D printing also increases. This waste can include failed prints, support material, and even old or outdated 3D printed objects. To address this issue, a new method of manufacturing 3D printing filament using 3D waste material has been developed. This process involves grinding up the waste material and then melting it down to create new filament. This method not only reduces waste but also reduces the cost of filament production. The process starts with collecting the 3D waste material and grinding it down into small pieces. The pieces are then fed into an extruder, where they are melted and formed into a uniform filament. The filament is then cooled and wound onto a spool, ready for use in a 3D printer. One of the main advantages of this method is that it allows for the creation of custom filaments with unique colors and properties. For example, adding carbon fiber to the waste material can create a filament that is stronger and more durable than traditional PLA or ABS filaments. Additionally, this method is environmentally friendly and sustainable, as it reduces the amount of waste generated by 3D printing and can also reduce the need for new raw materials. Overall, the manufacturing of 3D printing filament using 3D waste material is a promising development that has the potential to revolutionize the way we approach 3D printing and sustainability in manufacturing.

Nomenclature

PLA - Polylactic acid

ABS - Acrylonitrile Butadiene Styrene

II. LITERATURE REVIEW

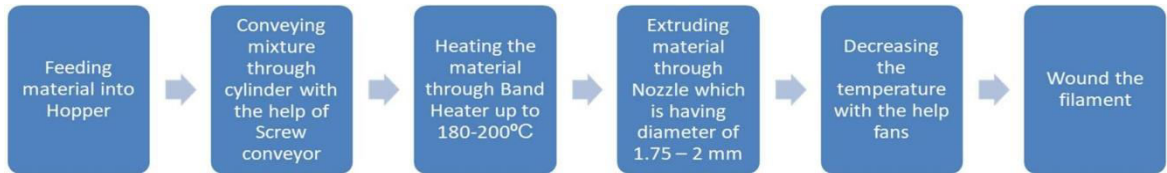
- A comparison between mechanical properties of specimen's 3D printed with virgin and recycled PLA: The current research was focused on a further insight into the mechanical properties of 3D parts printed with virgin and recycled polylactic acid (PLA). A first set of specimens was printed with virgin PLA filament and mechanically tested. Such specimens were then ground up and re-extruded into filament using a homemade.
- 3D printing filament as a second life of waste plastic: This paper focuses on a review of the available literature on the production of filaments for 3D printers from recycled polymers as the alternative to present approach of central selective collection of plastics. The possibility of recycling of basic thermoplastic materials and the impact of processing on their
- physicochemical and mechanical properties were verified. In addition, commercially available filaments produced from recycled materials and devices which allow self-production of filaments to 3D printing from plastic waste were reviewed.
- Experimental Investigation on Filament Extrusion using recycled materials: Fused Deposition Modeling (FDM) by Fused Deposition Modeling (FDM) is an essential tool in additive manufacturing and literature is based on context of manufacturing process, material, recycling plastics and the equipment used in the research. Therefore, the literature review has been divided in sub sections in order to have a clear view about the recycling of materials to get 3D printed objects.
- Design and manufacturing of a 3D printer filaments extruder: Based on 3D software was adopted. help to improve mechanical properties that behavior can changed by addition polymer.
- Additive manufacturing and its social impact: The study investigated the feasibility of using recycled high-density polyethylene (HDPE) as a 3D printing filament. The researchers found that recycled HDPE can be used as a 3D printing filament with some modifications in the printing process. The printing temperature and speed need to be adjusted to achieve a better print quality. The study concluded that using recycled HDPE as a 3D printing filament can help reduce waste and promote sustainable manufacturing.

Aim and Objective:

The objectives of manufacturing 3D printing filament using 3D waste material can include:

- ❖ Environmental sustainability: One of the primary objectives of using 3D waste material for 3D printing filament is to reduce the amount of plastic waste that ends up in landfills or the environment. By using waste plastic, we can reduce the need for virgin plastic and thus minimize the environmental impact of plastic production.
- ❖ Cost-effectiveness: Using waste plastic as raw material can be a cost-effective way to produce 3D printing filament as compared to using virgin plastic. This can be particularly beneficial for small businesses or individuals who want to produce 3D prints without incurring significant costs.
- ❖ Quality and consistency: The quality and consistency of 3D printing filament made from 3D waste can be comparable to that made from virgin plastic. The objective is to produce high-quality 3D printing filament that meets the requirements of 3D printers, including consistent diameter and strength.
- ❖ Innovation: The use of 3D waste as a raw material for 3D printing filament is an innovative approach that can lead to new products and applications. By exploring the potential of waste plastic as a material for 3D printing filament, we can discover new uses for plastic waste and reduce our reliance on virgin plastic.
- ❖ Community impact: The production of 3D printing filament using 3D waste can have a positive impact on local communities by creating employment opportunities and contributing to the circular economy. By supporting local businesses that produce 3D printing filament from waste plastic, we can help to build a more sustainable and resilient economy.
- ❖ Improved environmental impact: By reducing the amount of 3D waste, manufacturing 3D printing filament using waste plastic material can help reduce the environmental impact of plastic production and disposal.

III. METHODOLOGY



Hardware and Software Required:

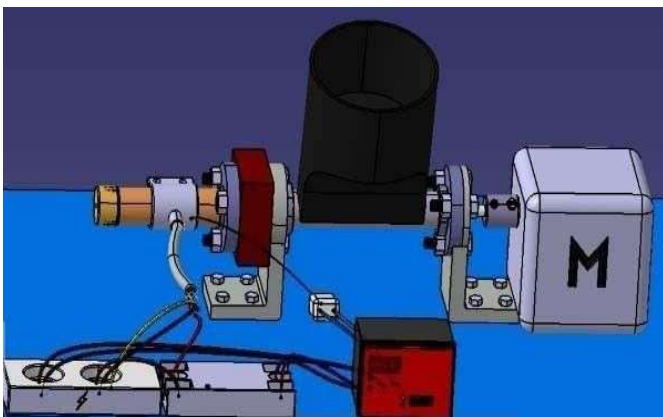
Software Requirement:

- Arduino(IDE)

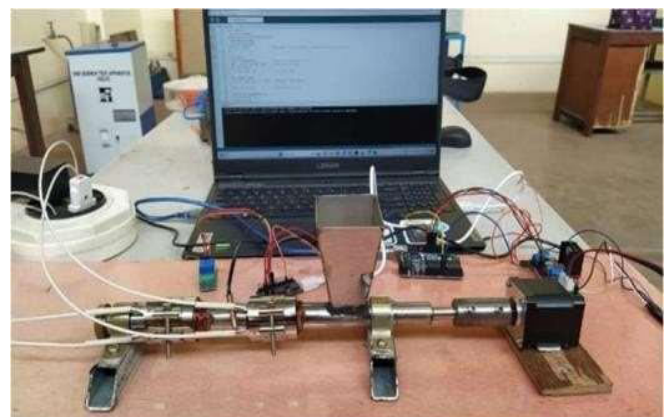
Hardware Requirement:

Components	QTY
Screw conveyor	1
Steel Pipe	1
Hopper	1
Copper Coil	2
Bush pin	1
Band heaters	2
Stepper Motor	1
Nozzle	1
Support plates	2

Schematic Diagram :



(a) Filament extruder machine design



(b) Filament extruder manufacturing machine

IV. RESULT

The machine was manufactured as per the computer-aided design as shown in Fig. (a). The waste filament is fed through hopper and a screw conveyor is rotated with the help of DC motor. The extruder machine shown in Fig. (b) was tested using pellets and waste 3D printing material at 200 °C which is the melting temperature of filament (PLA). The highest temperature achieved by the machine is 350 °C, but in order to provide a safety factor, the machine is used up to 250 °C temperatures. The filaments were produced using 2mm nozzle and stretched to get 1.75 mm diameter before its cooling. The output filament has tolerance of

± 0.1 mm. From the experimentation it is observed that if 30 % 3D printing waste filament is mixed with 70 % of fresh pellets then the quality of the output filament is much better than using 100 % waste filament.

V. CONCLUSION

Manufacturing 3D printing filaments using 3D waste material can have a significant impact on the environment by reducing the amount of waste produced by the 3D printing industry. It also provides a cost-effective solution for creating new filaments, as 3D waste materials are readily available and can be repurposed into new products. One of the challenges with using 3D waste materials for filament manufacturing is ensuring consistent quality and performance of the filaments. This requires careful sorting, cleaning, and processing of the waste materials. However, with advances in technology and research, it is possible to overcome these challenges and create high-quality filaments from 3D waste materials.

VI. FUTURE SCOPE

The future of manufacturing 3D printing filaments using 3D waste materials is promising, as more companies and individuals become aware of the benefits of sustainable practices. This has led to the development of new technologies and methods for producing high-quality filaments from 3D waste materials. In addition, the use of 3D waste materials for filament manufacturing can be extended to other industries, such as construction and packaging, further reducing waste and promoting sustainability. Overall, the future of manufacturing 3D printing filaments using 3D waste materials looks bright, and it is likely that we will see more innovative solutions emerge in the years to come.

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