

# Sustainable Materials in Additive Manufacturing

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### Project Aim

This dissertation is evaluating and comparing the types of materials in additive manufacturing (AM), such as 3D-Printing, in terms of their environmental impact and seeing if the current materials and printing methods can be improved as the practise of using AM grows.

### Objectives

- Review research journals relating to AM and sustainable materials.
- Study cases about Sustainable Materials and expand that impacts on products and the environment.
- Examine materials used in various printing methods to find the more sustainable material.
- Investigate how more eco-friendly and sustainable materials can be implemented.
- Conduct surveys focusing on the current state of sustainable materials in different companies.
- Develop recommendations for the AM technologies and devices to expand the field of application of sustainable materials.

### Background

- Sustainable materials are key to reducing 3D printing's impact. Biodegradable polymers and composites offer solutions, but challenges like degradation, recycling complexity, and cost remain.
- Research is needed to enhance renewables, supporting a circular economy with lasting benefits.. Achieving this requires industry collaboration, supportive policies, and a focus on product life cycles.

#### RECYCLING MATERIALS



Figure.1 Recycling Materials

### Materials & Uses

- This research compares different sustainable and environmentally friendly materials used in AM. Material sustainability is essential due to industry's rapid expansion and its uses in industries.
- Examples of uses: Manufacturing, modular and medical components.
- This dissertation evaluates the material characteristics, reusability, and their possible influence in the future of AM by examining studies, journals, and outside sources such as Granta EduPack.



Figure.2 Types of Materials available

### Challenges

- Challenges like material degradation, recycling, and consistency must be addressed. While cost and performance remain concerns, industry awareness is growing.
- Future efforts should enhance recycling and develop high-performance materials, guided by Life Cycle Assessment (LCA) for sustainability.



Figure.3 FDM 3D-Printer

### 3D Printing in Ireland

There are a multitude of companies in Ireland such as, 3D Printing Ireland, that provide services such as, 3D printing, 3D scanning, and 3D modelling for both large and small scale projects for external companies and individuals. They offer solutions which are more economical alternatives to the more traditional workflows, with a higher quality of results.

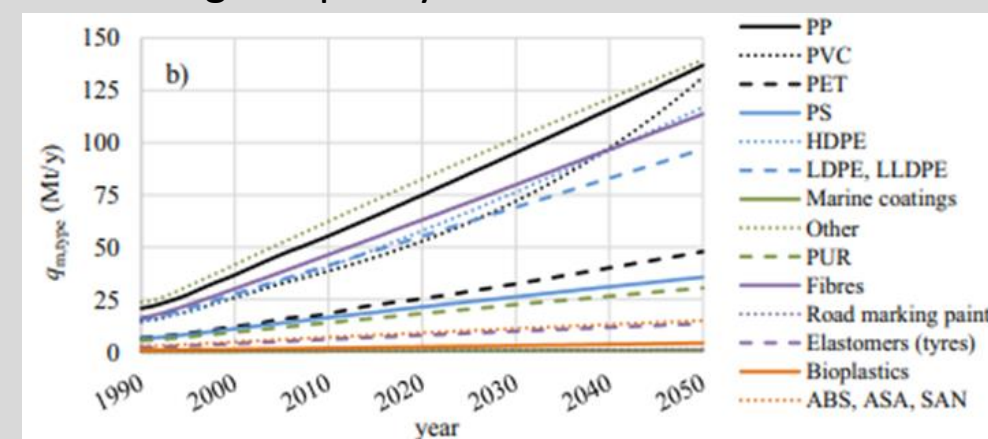


Figure.1 Usage of Materials Over Time

As 3D printing expands, material choices greatly impact the environment. Global plastic use is expected to rise significantly, highlighting the need for sustainable materials in additive manufacturing for both commercial and hobby applications.



Figure.2 Arm Orthosis made from PLA

3D printing has shifted from prototyping to a key manufacturing method, emphasizing the need for sustainable materials. FDM reduces waste and chemical use, while recyclable RPET, ABS, and renewable PLA support sustainability with lower energy use and biodegradability.

### Findings

- 3D printing demand for sustainable materials is rising.
- FDM is the most common technology with PLA being more eco-friendly than ABS. Recycled plastics (RPET, ABS) promote a circular economy.
- Composites with natural materials (e.g., wood fibres, date palm leaves) enhance sustainability.
- Sustainability varies by technology, although SLA resins are less sustainable, improvements are underway.
- Mechanical engineers are major 3D printing users, but cost and material performance are slowing the adoption process.
- Recycling polymer composites is challenging, and recycled polymers degrade after multiple cycles.
- Life Cycle Assessment shows 3D printing has a lower carbon footprint for small production runs compared to traditional manufacturing.

### Conclusion

Sustainable materials are key to reducing 3D printing's impact. PLA is a greener alternative to ABS, while recycled PET, ABS, and natural waste composites enhance sustainability. Challenges like degradation, recycling complexity, and costs remain. Industry collaboration, supportive policies, and research are vital for advancing affordable, high-performance sustainable materials.

### References

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