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Recycle of PA12 Scrap: Mechanical and Structural Performance of FDM Printed Parts from SLS Waste

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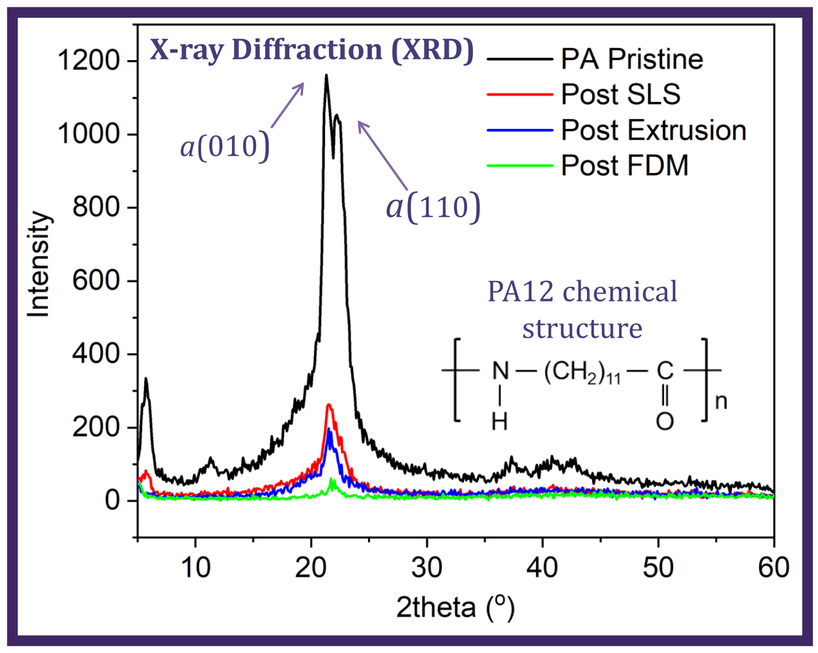
INTRODUCTION & AIM

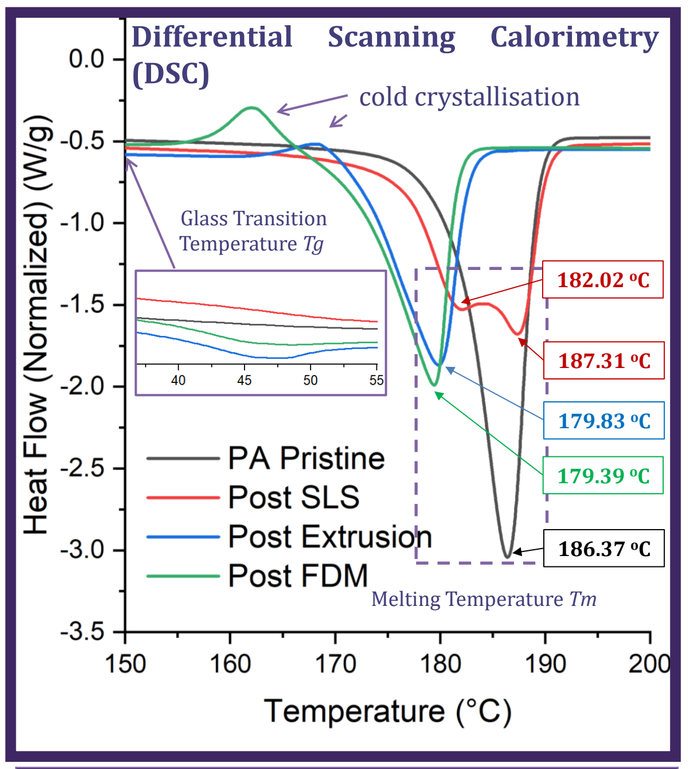
Selective Laser Sintering (SLS) of polymers such as PolyAmide12 [PA12] produces quantities of unfused powder and faulty prints that typically create significant material waste. This work proposes a recycling route to convert PA12 scrap from SLS into new feedstock for Fused Deposition Modeling (FDM). SLS waste was mechanically pulverized, reprocessed through filament extrusion, and used to print standardised test specimens. The study aims to evaluate how repeated thermal cycles influence the structural properties and mechanical performance of recycled PA12.

METHOD

RESULTS & DISCUSSION

Structural Properties



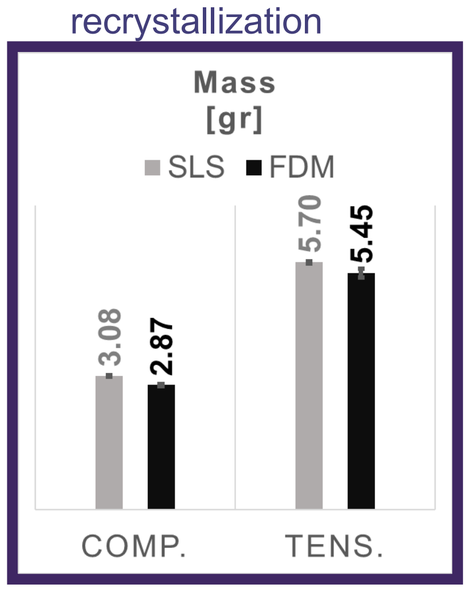


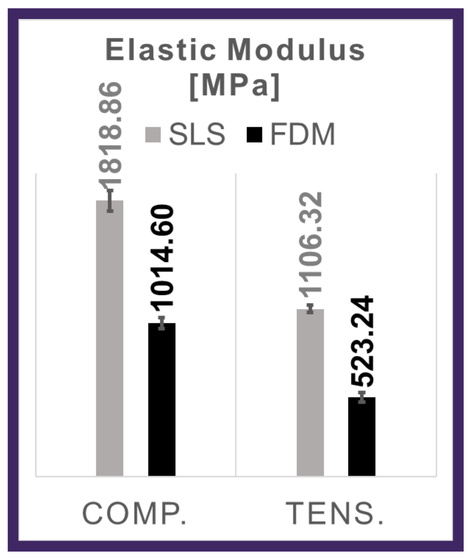
As PA12 is repeatedly heated:

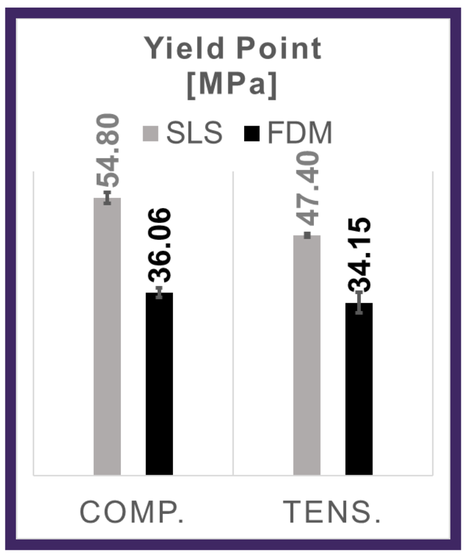
- α-phase peaks decrease and broaden
- crystals become smaller and less ordered
- amorphous content increases
- melting Temperature [Tm], melting enthalpy [H] and crystallinity drop [Xc]
- cold-crystallisation becomes more pronounced
- fast cooling during extrusion/FDM suppresses recrystallization

	A [W*C/s]	H [J/g]	Xc [%]
Pristine	15.19	91.14	43.57
P-SLS	11.95	71.70	34.27
P-Extr.	8.14	48.81	23.33
P-FDM	8.17	49.02	23.43

Mechanical Performance







Compression and tensile tests were conducted on five specimens per process (SLS and recycled-PA12 FDM). The diagrams show:

- FDM specimens showed slightly lower mass than SLS samples, reflecting differences in density and print architecture.
- SLS parts exhibited higher elastic modulus and yield strength in both tests.
- The reduced performance of FDM parts is attributed to repeated thermal cycles, causing polymer chain degradation, poorer interlayer bonding, and micro-void formation.

These mechanical trends correlate with structural findings (XRD/DSC), where lower crystallinity and weaker α-phase ordering in recycled-FDM material led to diminished stiffness and strength.

CONCLUSION

This study demonstrates that PA12 SLS scrap can be successfully recycled into functional FDM filament. Although repeated thermal cycles reduce crystallinity and mechanical performance, the recycled material remains suitable for non-critical applications. The process offers a practical route to reduce polymer waste and support circular-economy practices in additive manufacturing.

FUTURE WORK / REFERENCES

- Optimize extrusion and printing parameters for improved filament consistency
- Investigate chain stabilizers or fillers to restore crystallinity and strength
- Assess recyclability over multiple cycles to understand long-term material behavior

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