

TWENTY-THIRD INTERNATIONAL CONFERENCE ON COMPOSITE MATERIALS (ICCM23)



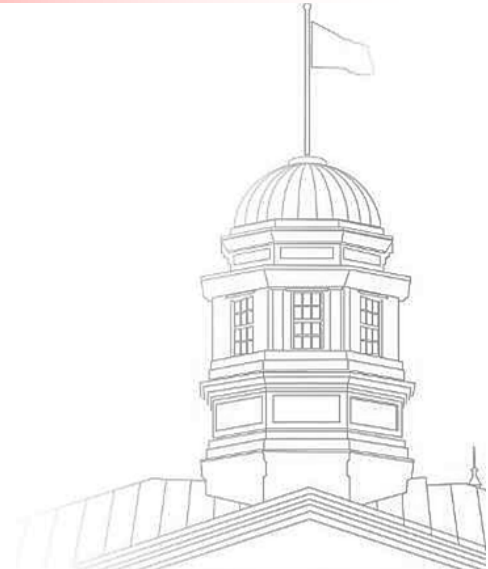
Manufacturing of Polyetherimide (PEI)-Polycarbonate (PC) Blends for Fused Filament Fabrication

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Structures & Composite Materials
Laboratory

Research Center for High Performance Polymer and
Composite Systems



Introduction: Fused Filament Fabrication (FFF)

Solidification behavior:

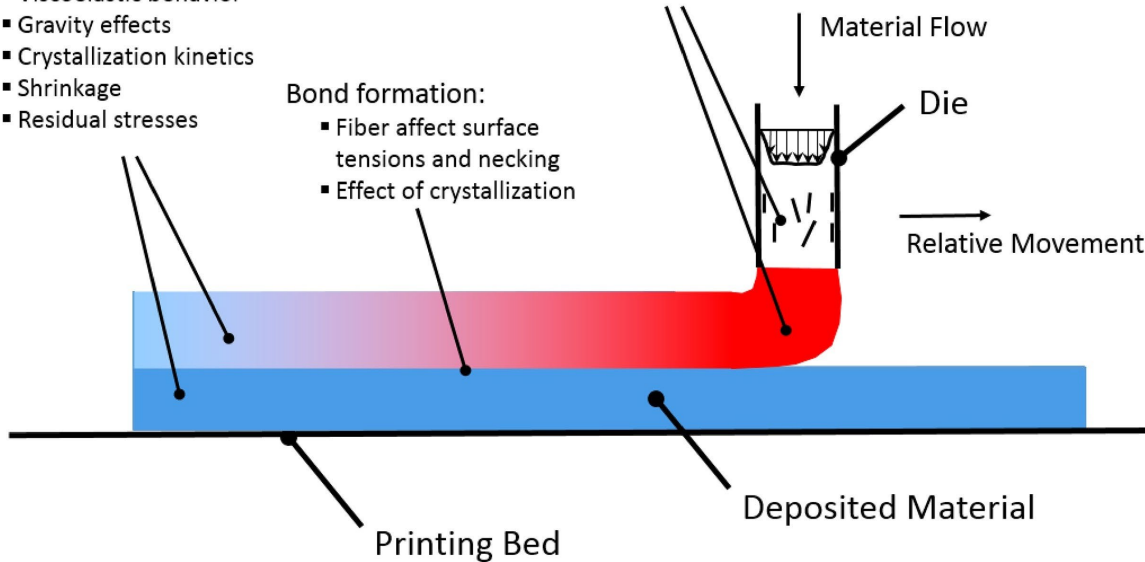
- Cool down
- Viscoelastic behavior
- Gravity effects
- Crystallization kinetics
- Shrinkage
- Residual stresses

Flow and fiber orientation:

- Viscous suspension flow
- Flow and fiber orientation mutually dependent

Bond formation:

- Fiber affect surface tensions and necking
- Effect of crystallization



Challenges

- Expensive
- Limited to lower temperature
- Print instability

Solutions

Polymer blend

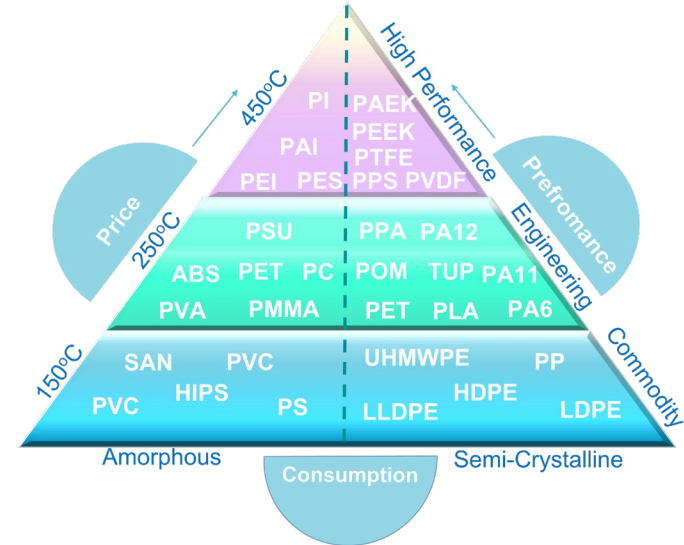
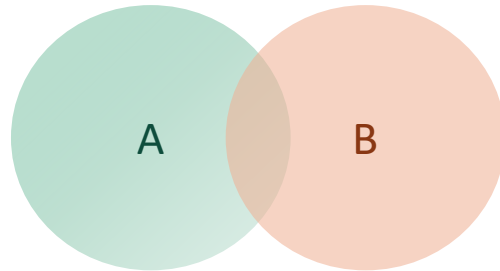
FFF Process and its related phenomenon

Introduction: Polymer Blends

What are polymer blends



A **polymer blend** is a physical mixture of two or more polymers.

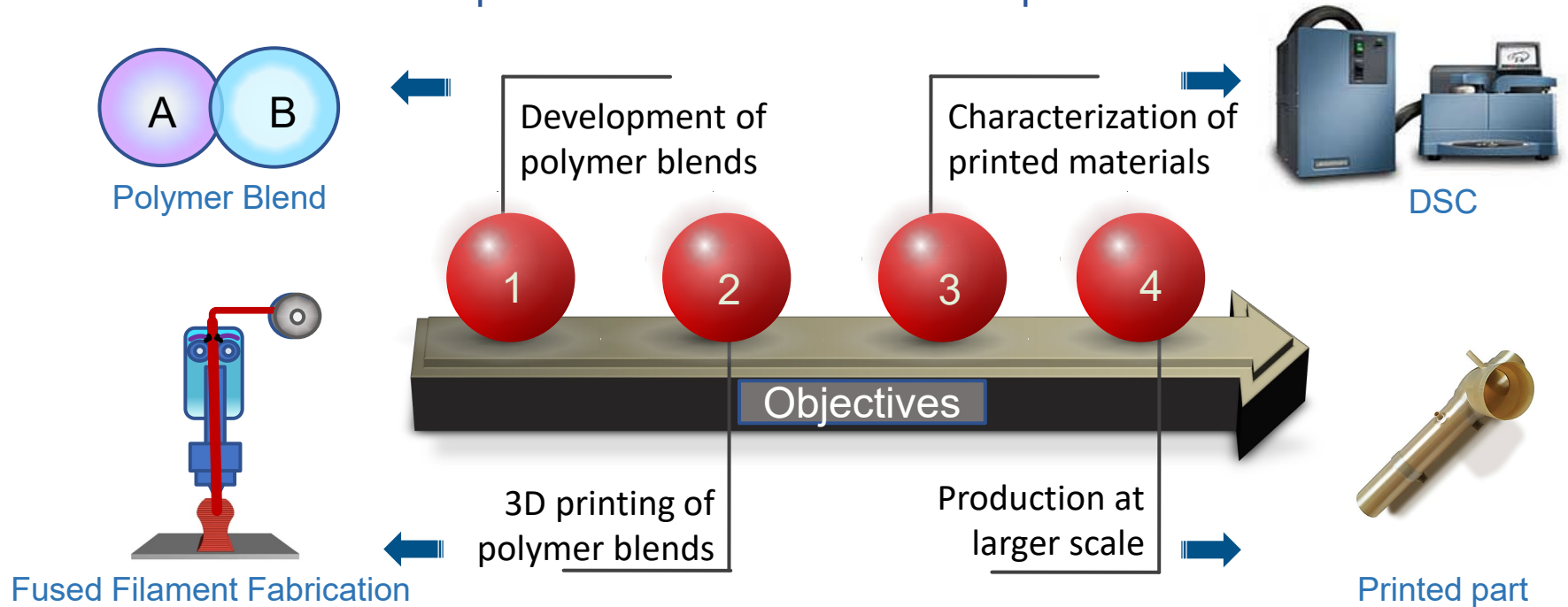


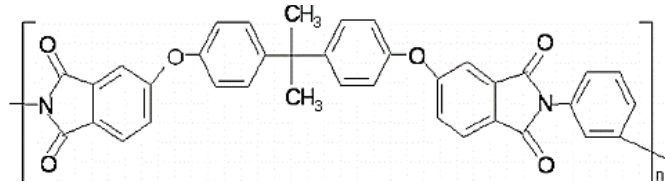
Advantages:

- Cost effective
- Efficient way of manufacturing
- Performance can be tuned

Objectives

Goal: Develop novel filaments using polymeric blends for 3D printing to enhance the performance and reduce the price





Polyetherimide (PEI)

P
R
O
P
E
R
T
I
E
S

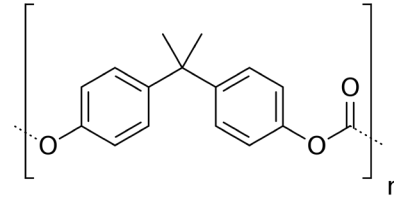
Higher mechanical properties

Good chemical resistance

Lower water absorption

Poor impact strength

Poor toughness



Polycarbonates (PC)

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Lower mechanical properties

Lesser chemical resistance

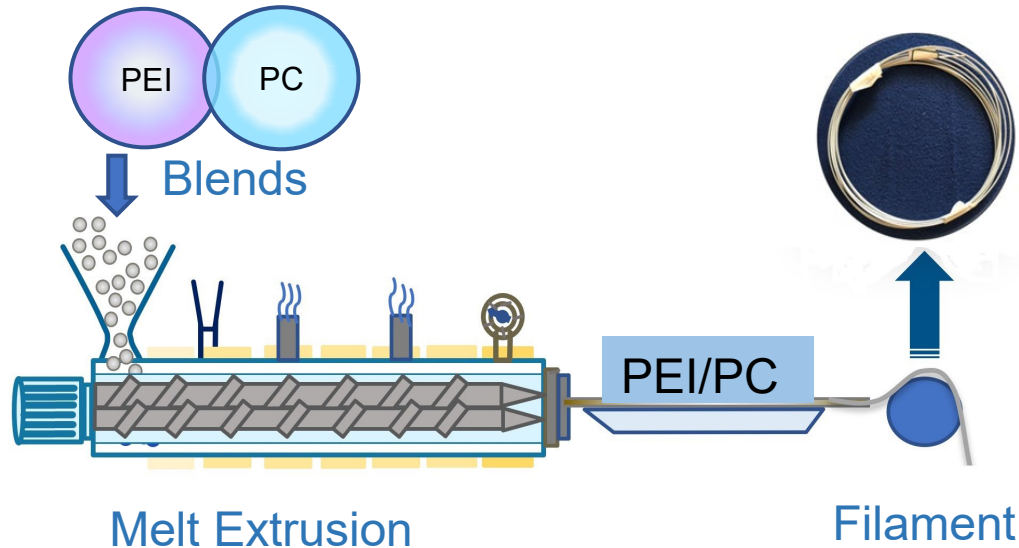
Higher water absorption

Higher impact strength

Higher toughness

PEI:PC filament preparation

Step 1-2 : Optimization of polymer blending process and development of filaments



No.	Polymer blend name	PEI (Wt%)	PC (Wt%)
1.	Neat PEI	100	0
2.	PEI:PC9010	90	10
3.	PEI:PC7030	70	30
4.	PEI:PC5050	50	50
5.	PEI:PC1090	10	90

Filaments Characterization (1/4)



Neat PEI



PEI:PC9010



PEI:PC7030



PEI:PC5050



PEI:PC1090

Filaments Characterization (2/4)



Neat PEI



PEI:PC9010



PEI:PC7030



PEI:PC5050

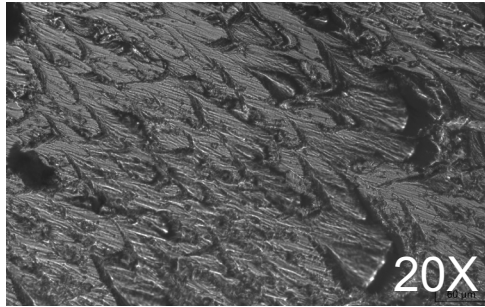


PEI:PC1090

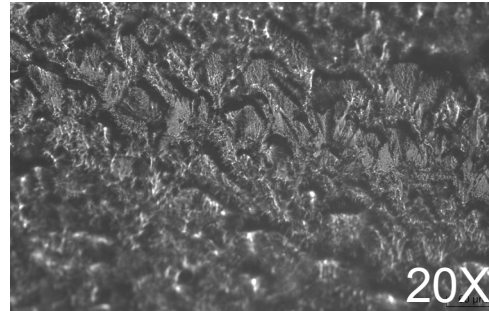
- Smooth surface: PEI/PC 70:30

- Rough surface PEI/PC 50:50

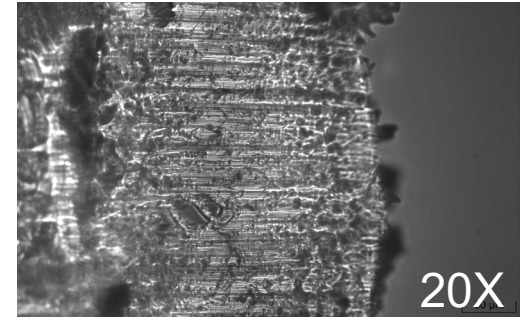
Filaments Characterization (3/4)



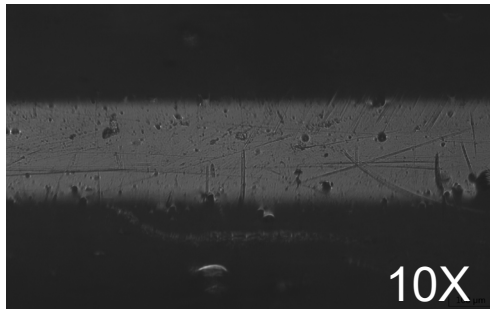
PC



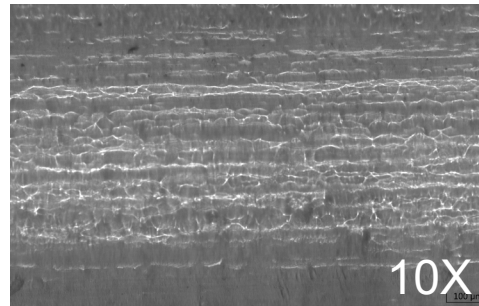
PEI:PC7030



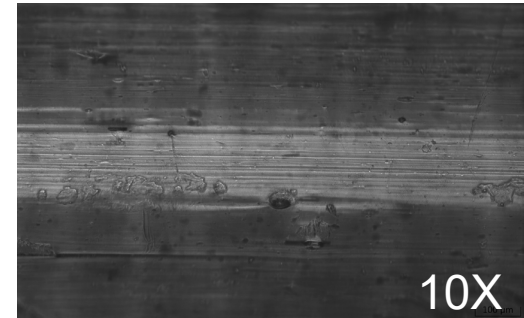
PEI



10X

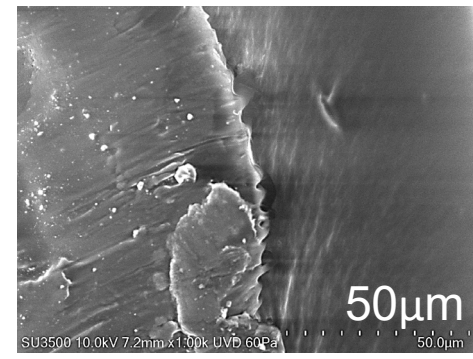
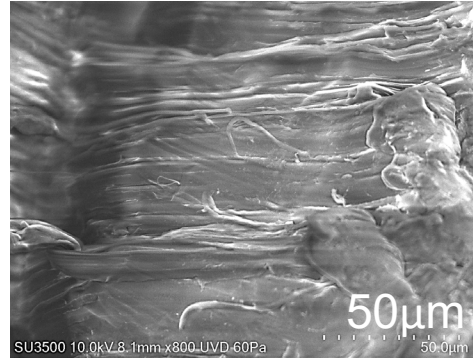
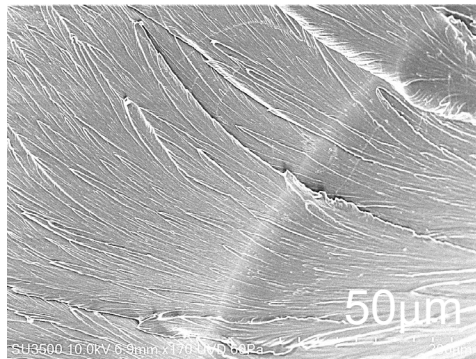
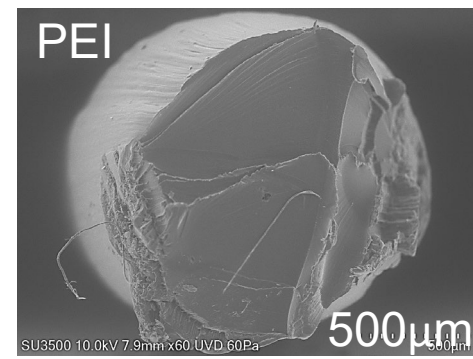
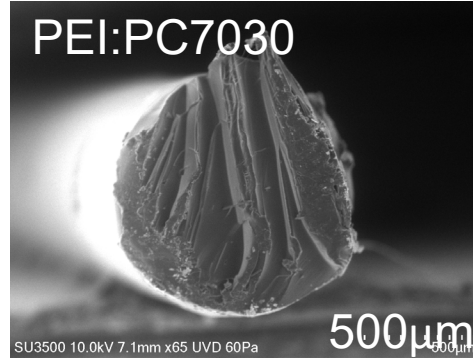
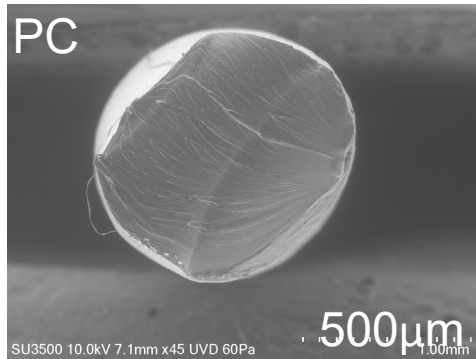


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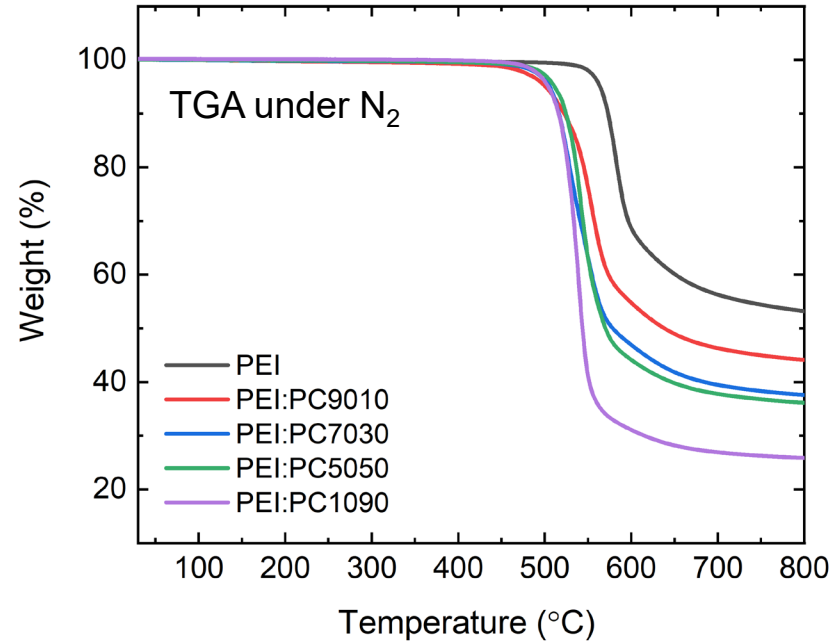
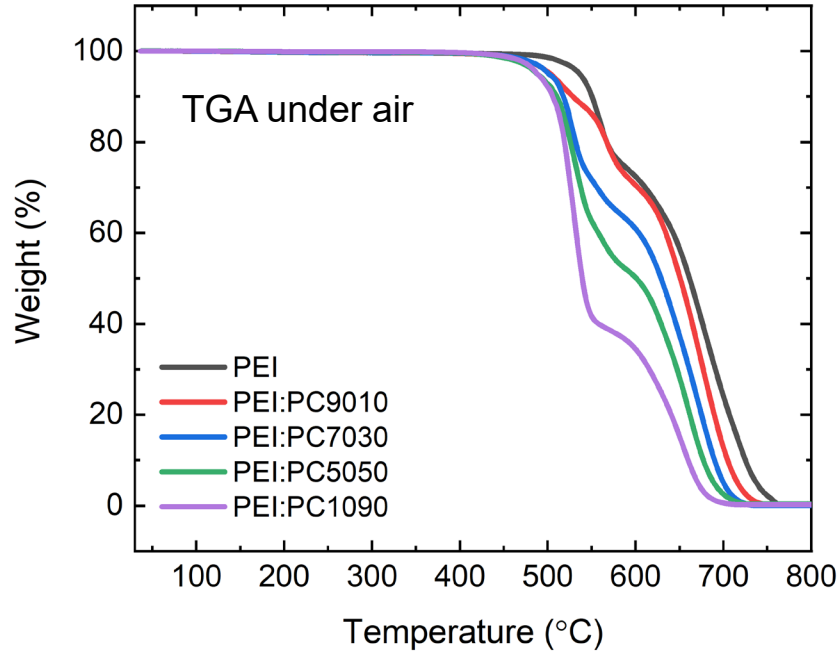


10X

Filaments Characterization (4/4)



Filaments thermal stability (1/2)



Filaments thermal stability (2/2)

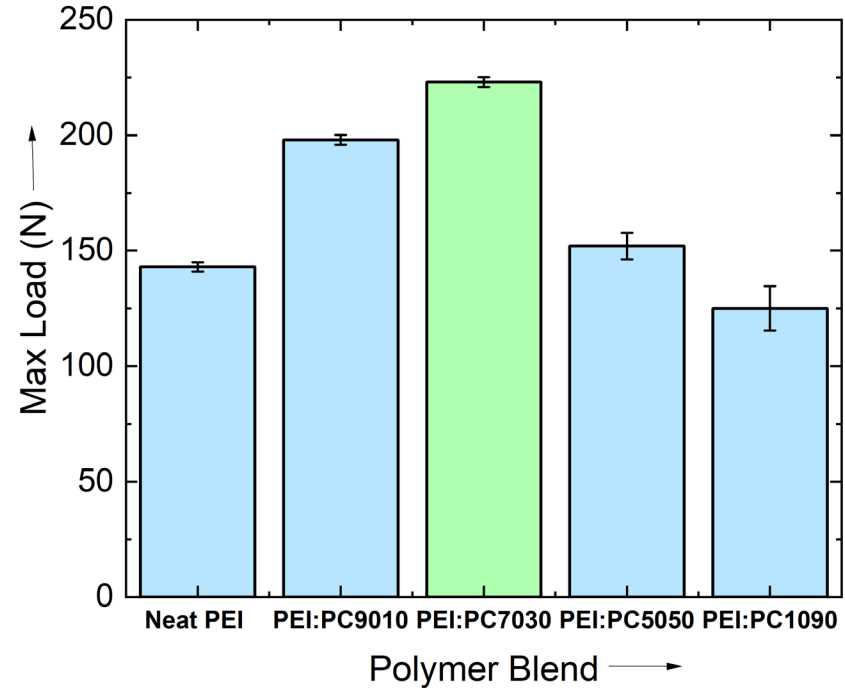
TGA under air

No.	Polymer blend name	Td (5%)	Td (30%)
1.	Neat PEI	536	610
2.	PEI:PC9010	492	592
3.	PEI:PC7030	488	542
4.	PEI:PC5050	474	524
5.	PEI:PC1090	477	515

TGA under N₂

No.	Polymer blend name	Td (5%)	Td (30%)
1.	Neat PEI	564	597
2.	PEI:PC9010	524	581
3.	PEI:PC7030	528	563
4.	PEI:PC5050	522	556
5.	PEI:PC1090	514	544

Filaments tensile properties

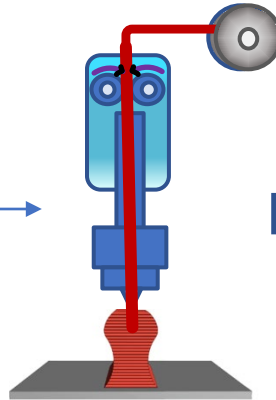


- Samples were tested at 50 mm/min rate

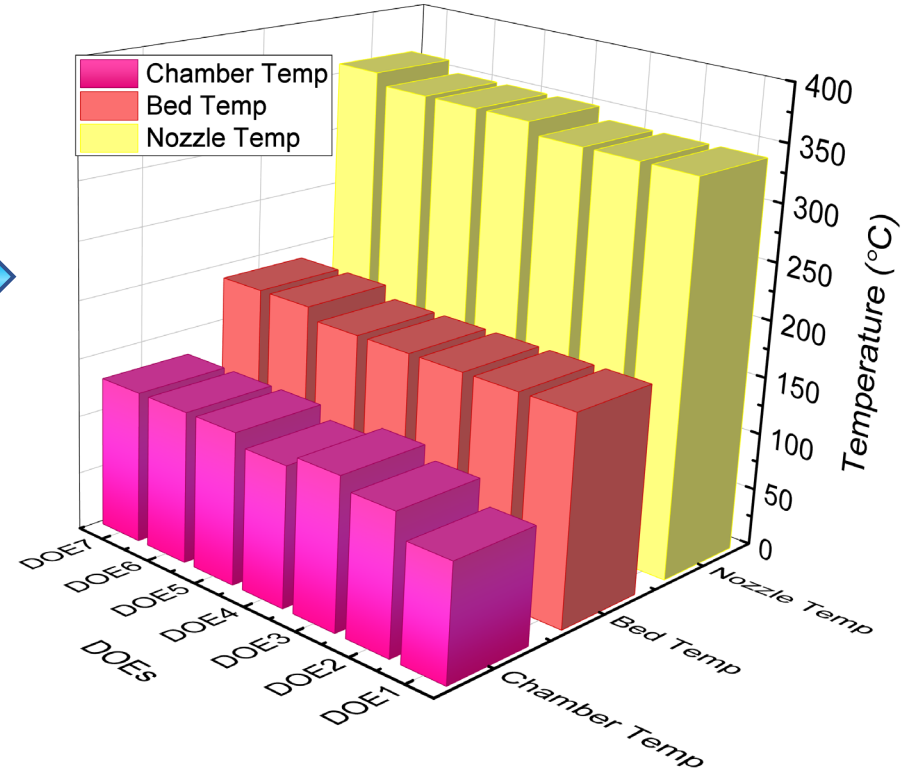
Filaments printing (1/2)



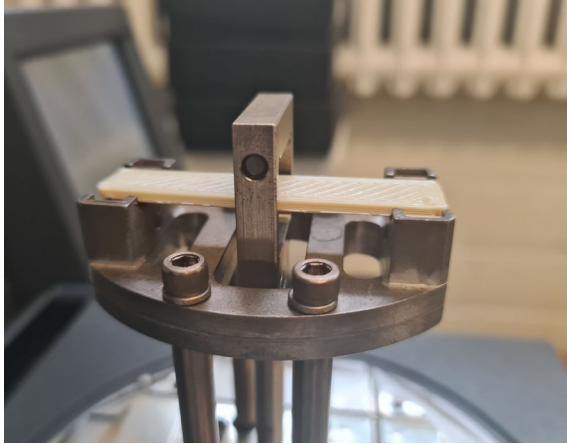
Printed on AON3D



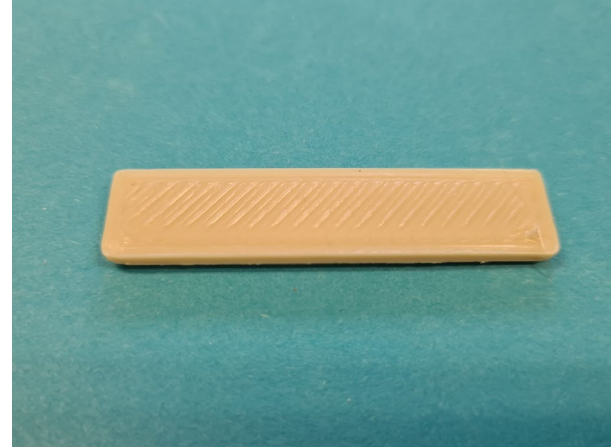
FFF



Characterization of printed samples



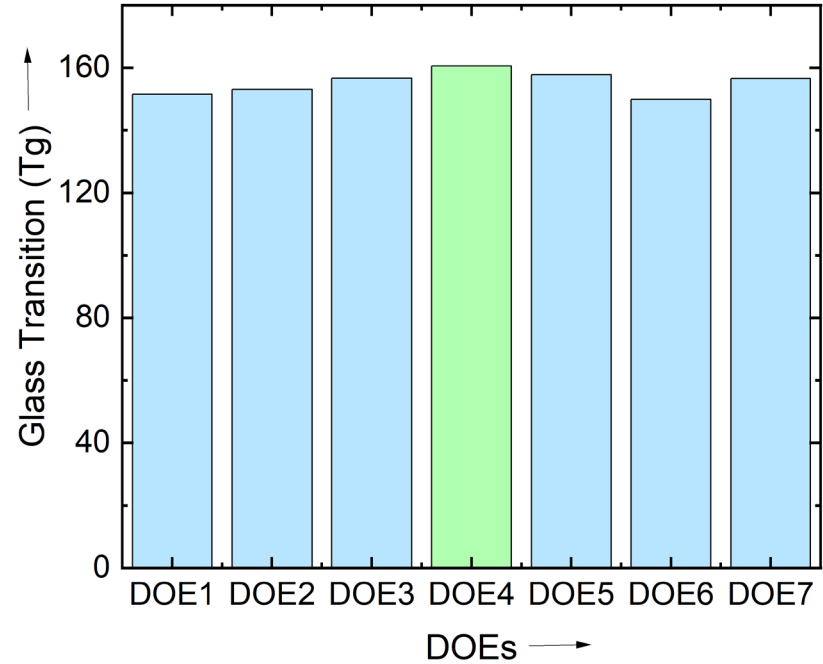
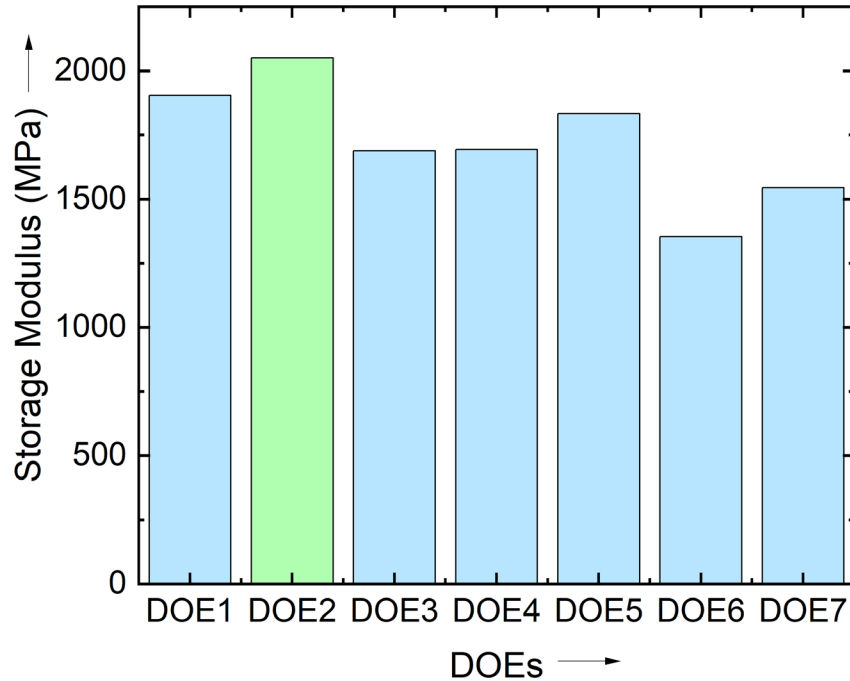
DMA Sample Loading



+45-45°

Test Conditions: Ramp at 3°C to 220°C

Characterization of printed samples (2/2)



- PEIPC blends and their filaments were successfully developed via extrusion process.
- Produced PEIPC filaments were characterized via OM, SEM, DSC, TGA and DMA.
- PEIPC:7030 showed highest mechanical properties as compared to neat PEI.
- PEIPC:7030 filament utilized for printing DMA samples and exhibited good mechanical properties and potentially be used for printing larger parts.
- Prepared blends can be cost effective compared to commercially available filaments with significant properties that can be used for FFF.



Acknowledgments

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Parc La Fontaine, Montreal

Thank you for your kind attention !!!