DESIGNING HIGH-PERFORMANCE CONDENSATION POLYMERS FROM REUTILIZATION OF PLASTIC WASTE AND NOVEL BIOBASED BUILDING BLOCKS

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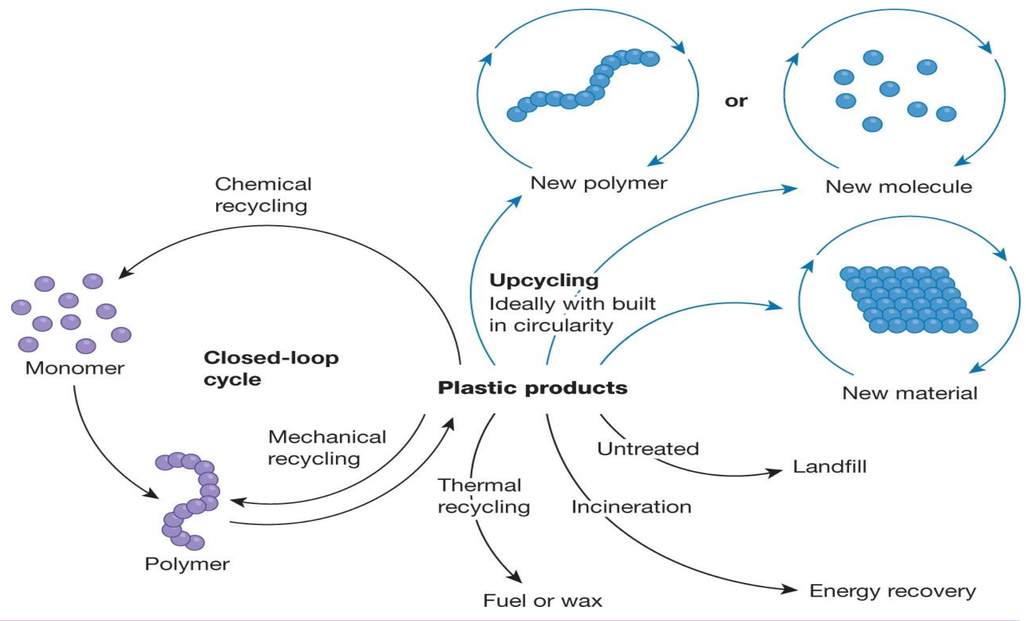
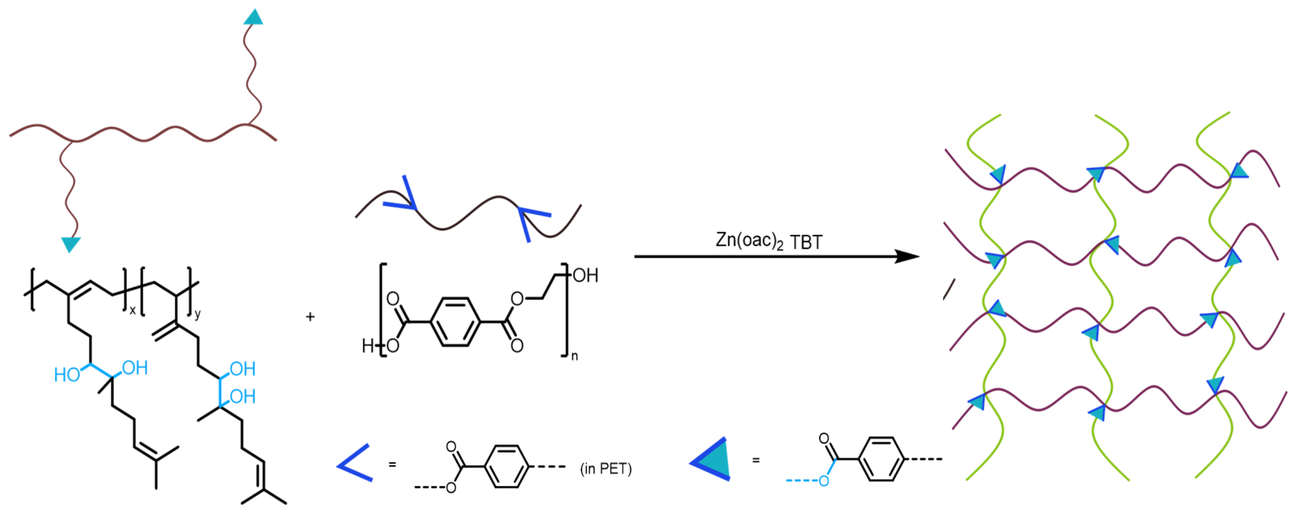
Background: Polymer Upcycling

- Transforms waste plastics into high-performance materials with customized thermal/mechanical properties[1]
- convert PET/polyesters into value-added polymers for 3D printing and engineering applications[2]
- 94% energy savings vs virgin plastic production while diverting 450M tons/year from landfills[3]



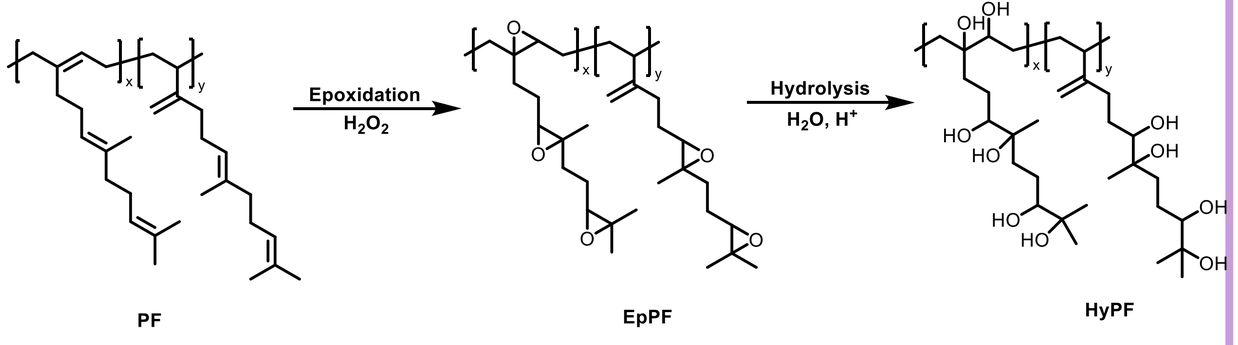
Project Overview

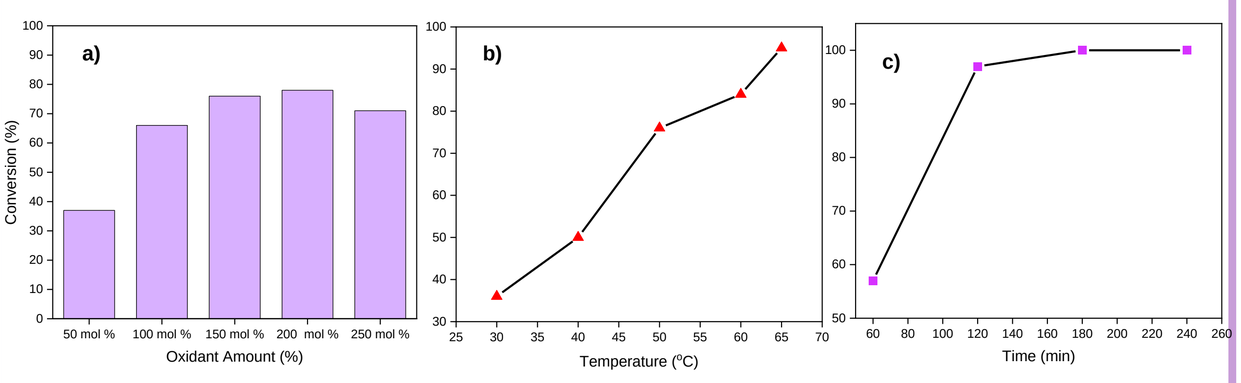
- Functionalization of biobased polymer Polyfarnesene (PF) into Hydrolyzed Polyfarnesene (HyPF)
- Upcycling of Recycled PET (rPET) waste with HyPF
- Reconfigurable Vitrimers (PETHyPF_VIT) by polycondensation of rPET with HyPF
- One pot depolymerization-vitrimerization strategy of rPET and HyPF using EMIC as catalyst and NMP as solvent



> ➢ *Functionalization of PF into HpPF and using it to make reconfigurable vitrimers with rPET using dynamic transesterification chemistry*

Functionalization of Polyfarnesene





Graphs showing the effect of a) oxidant concentration b) temperature c) Time on the conversion of Polyfarnesene to Epoxidized Polyfarnesene

Polycondensation of PET and HyPF

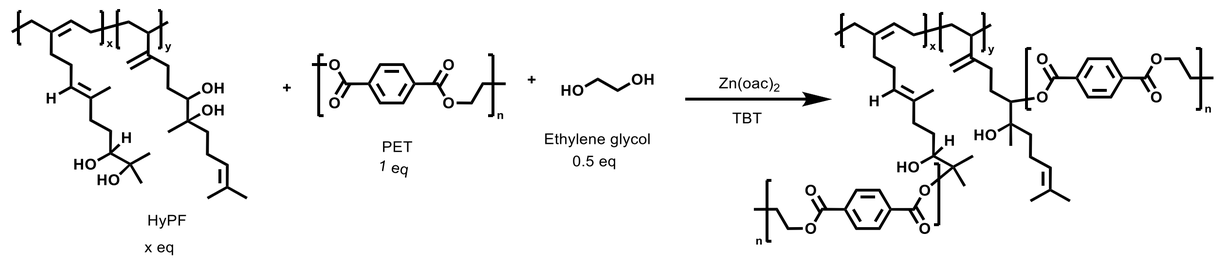
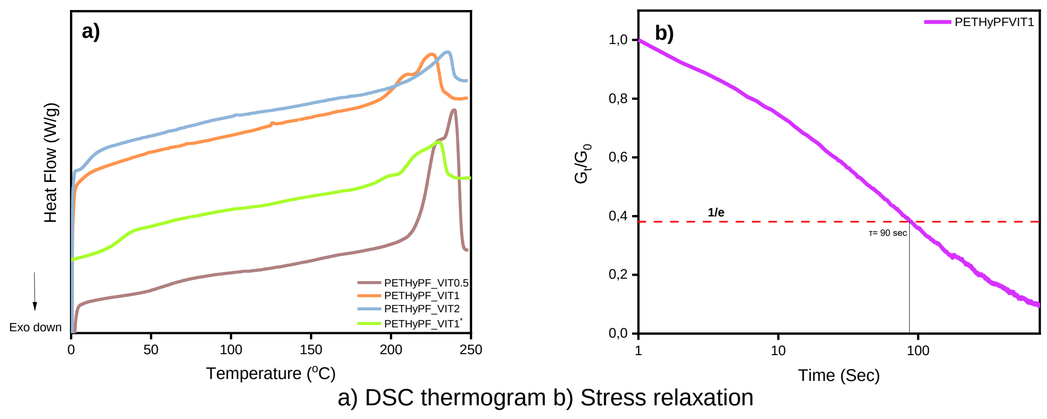
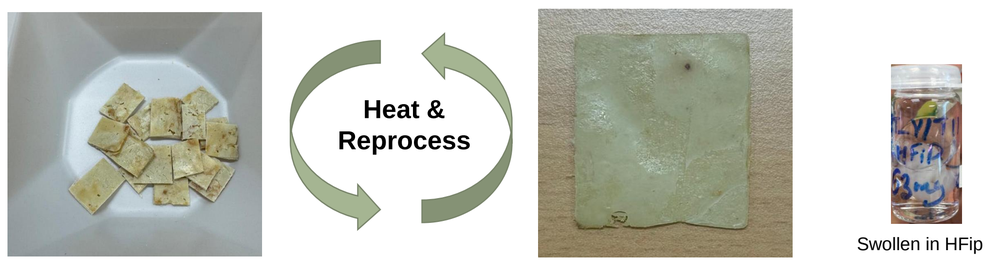


Table – Thermal Properties of PETHyPF_VITx

Sample	T_g (°C)	T_m (°C)	ΔH_m (J/g)	ΔH_c (J/g)	Gel Content (%)	τ (sec) @ 260°C
PETHyPF_VIT0.5	51	240	47.271	46.697	40	-
PETHyPF_VIT1	-	225	23.414	22.821	48	90
PETHyPF_VIT2	-	235	13.395	12.525	75	-
PETHyPF_VIT1*	31	230	16.555	17.227	74	30



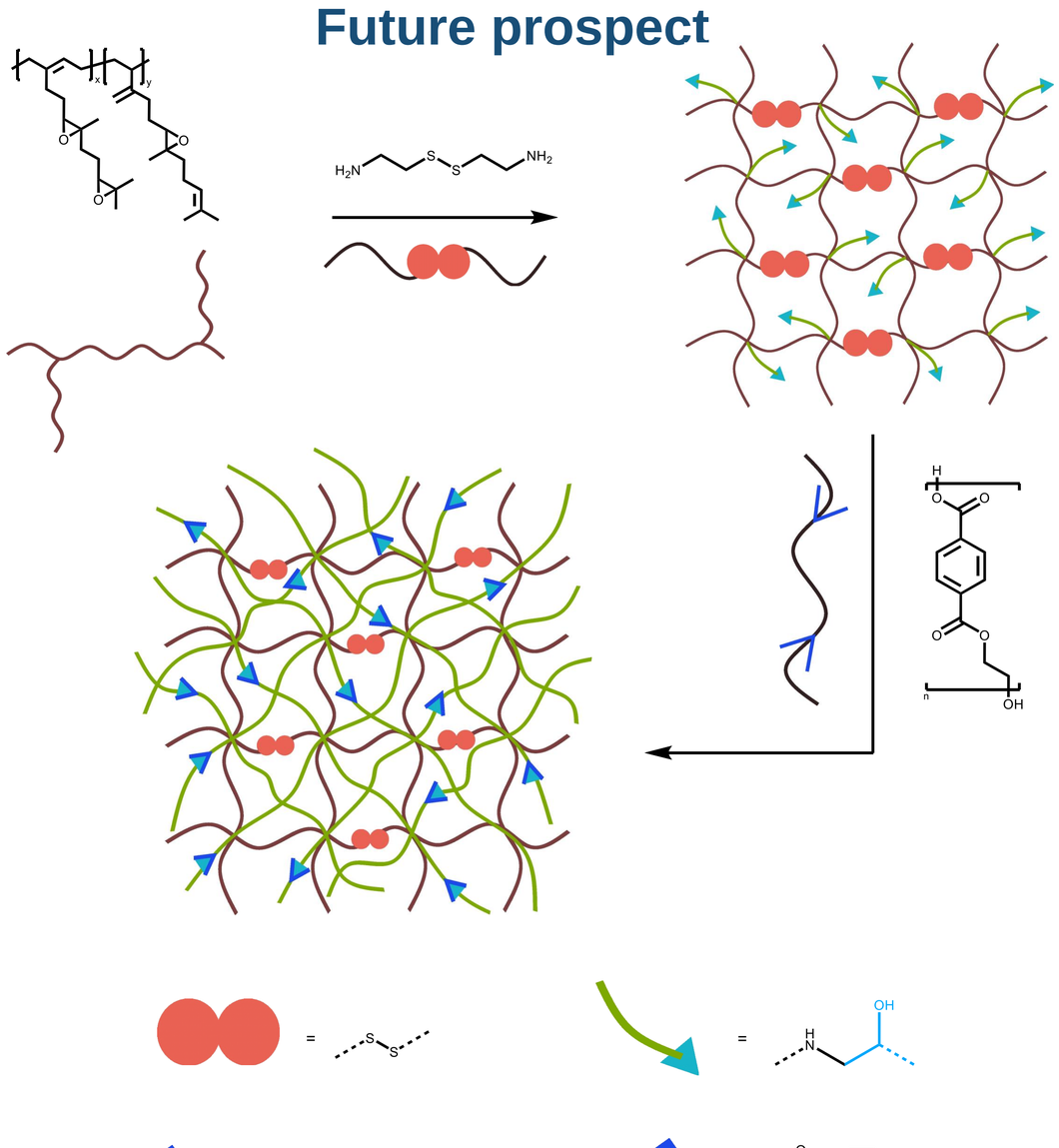
a) DSC thermogram b) Stress relaxation

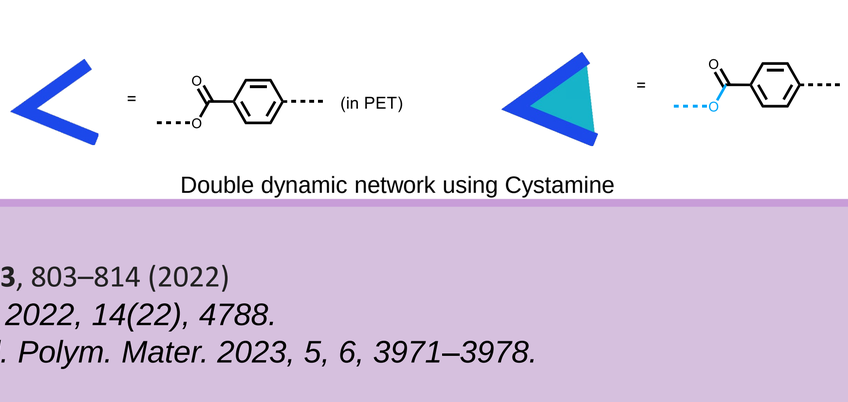


Swollen in HFip

Thermal reforming of Self-healing vitrimers through Heat pressing

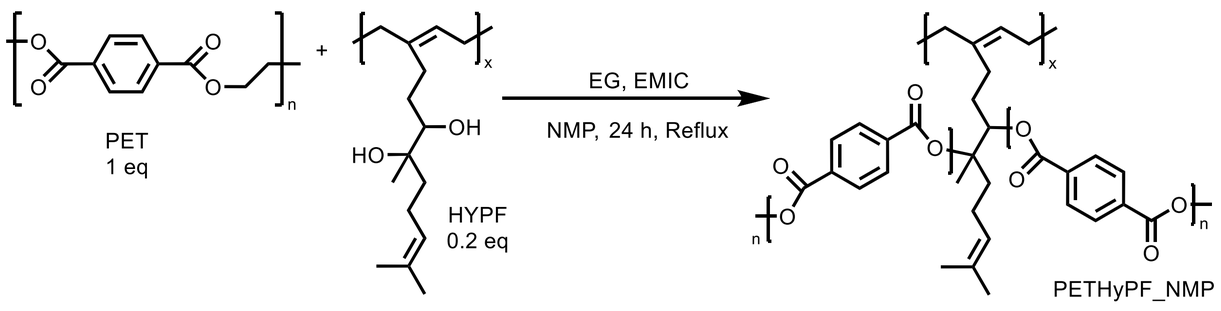
Future prospect





Double dynamic network using Cystamine

Depolymerization – Vitrimerization strategy



a) Isothermal DSC b) DSC thermogram

Melt press - 230°C - 5 min

References

1) *Nature* **603**, 803–814 (2022)
2) *Polymers 2022, 14(22), 4788.*
3) *ACS Appl. Polym. Mater. 2023, 5, 6, 3971–3978.*

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