



Synthesis and characterization of bio-based monomers for photo-curable polymer applications

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Particular applications of bio-based materials



Applications for bio-based materials

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renewable content



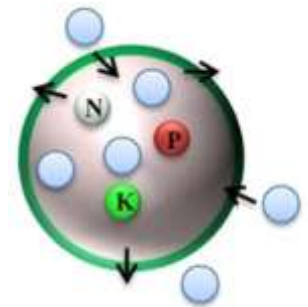
Dishes
and
packaging



Paper
surface
modification



Bio-based resin
for SLA 3D
printing



Controlled-
release
fertilizers



Applications for bio-based materials

Increasing the
renewable content



Dishes
and
packaging



Paper
surface
modification



Legislation of certain
packaging materials



More **convenient**
recycling process
(biodegradability)



Applications for bio-based materials

Increasing material portfolio ←

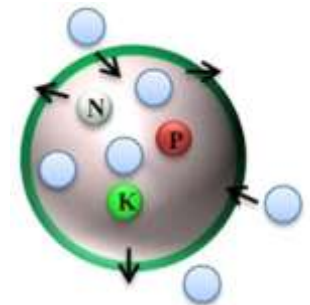
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Excluding fully artificial polymers for the environment

Varying used material



Bio-based resin for SLA 3D printing



Controlled-release fertilizers



Suggested syntheses and results

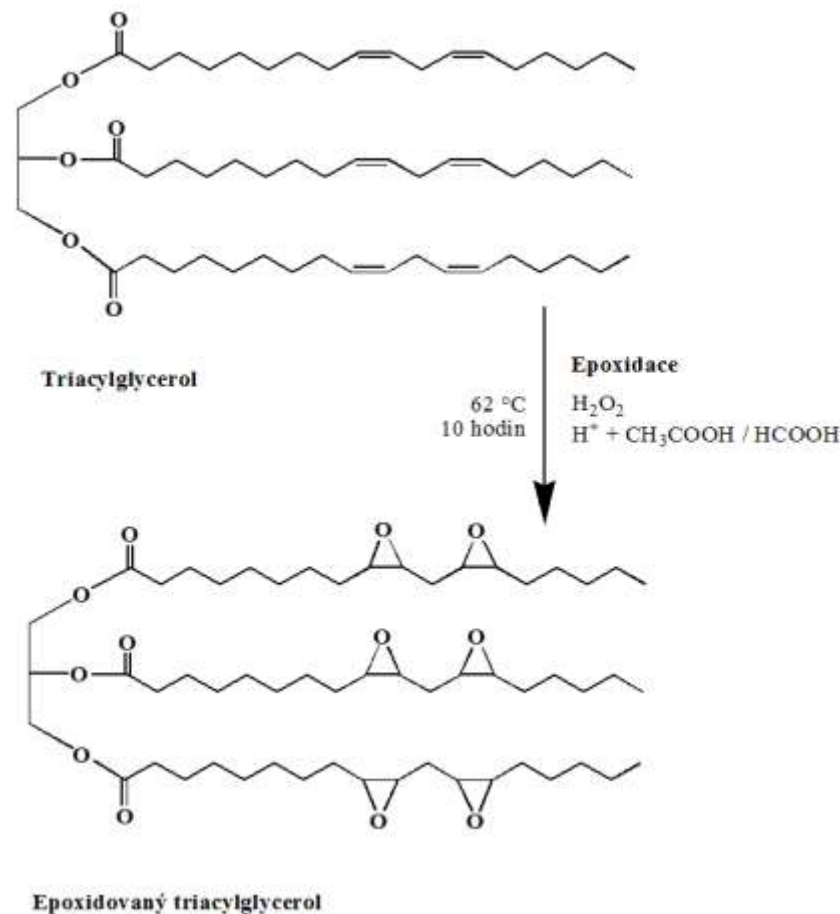


Syntheses of used monomers

1) Epoxidation of vegetable oil



2) Methacrylation of the epoxidized oil



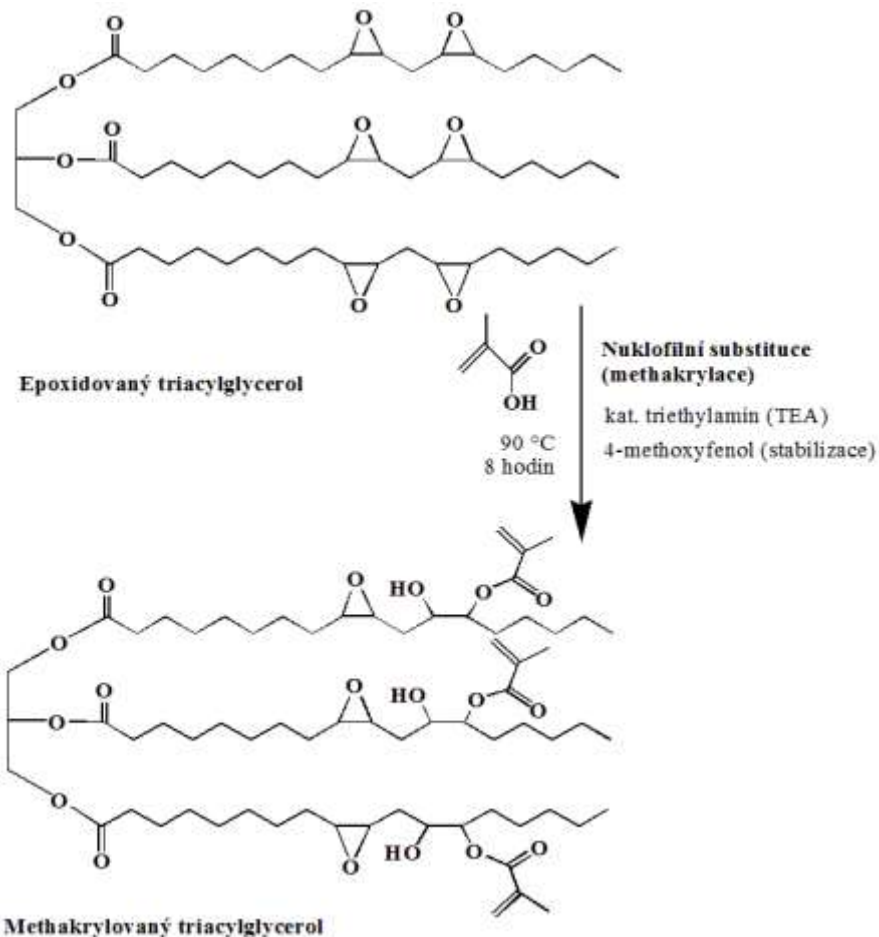


Syntheses of used monomers

1) Epoxidation of vegetable oil



2) Methacrylation of the epoxidized oil

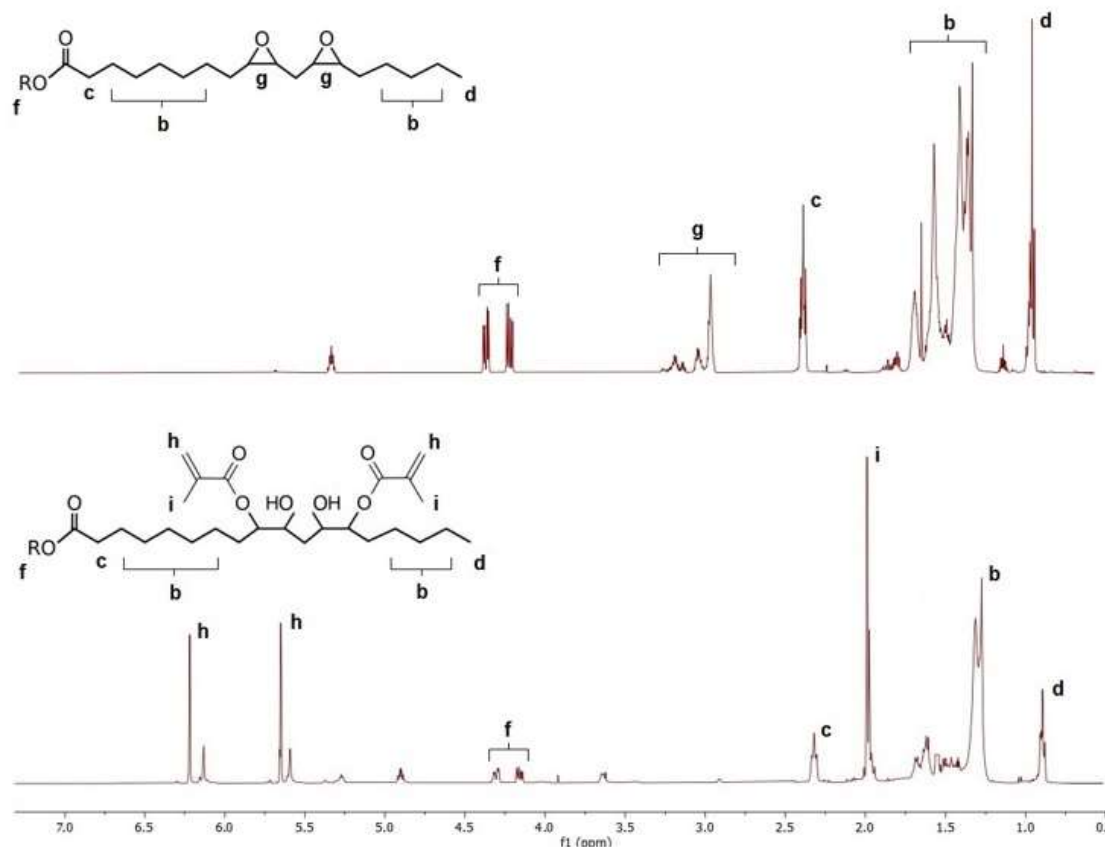




Syntheses of used monomers

Methacrylated vegetable oil verification

¹H NMR

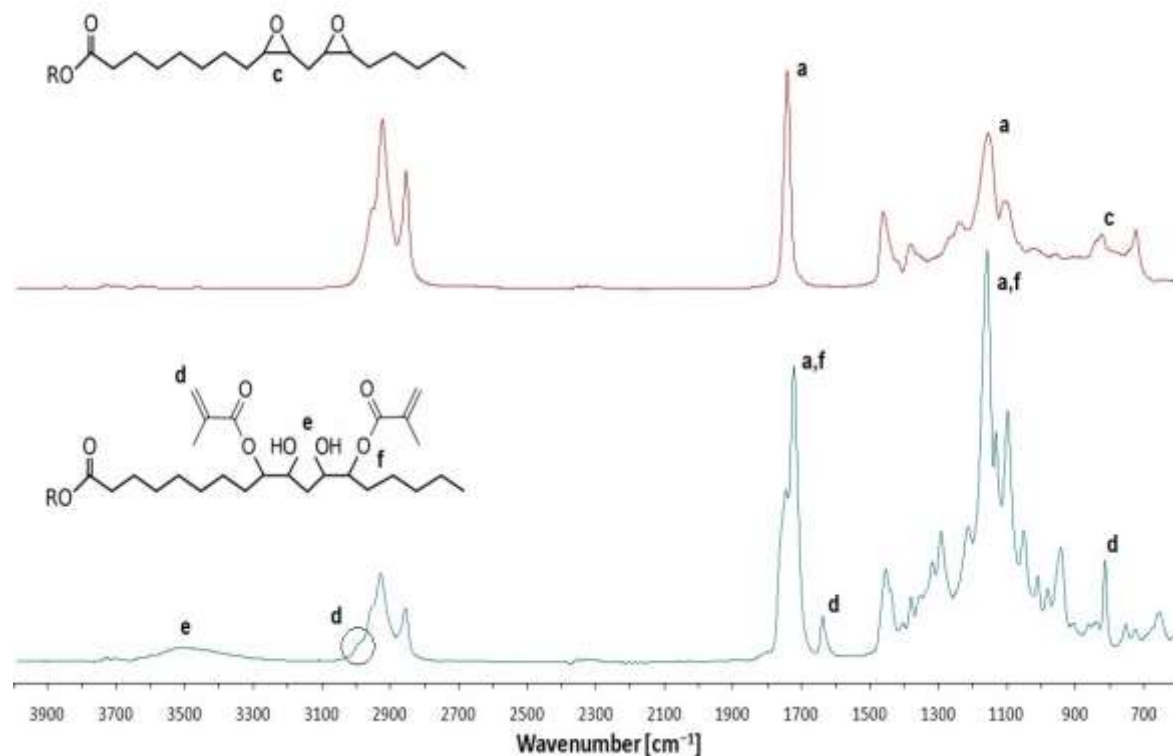




Syntheses of used monomers

Methacrylated vegetable oil verification

FT-IR



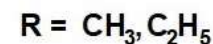
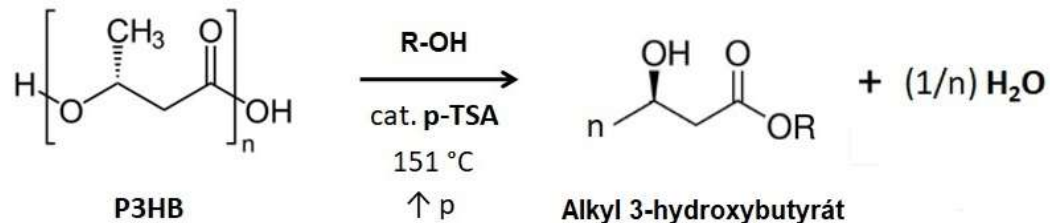
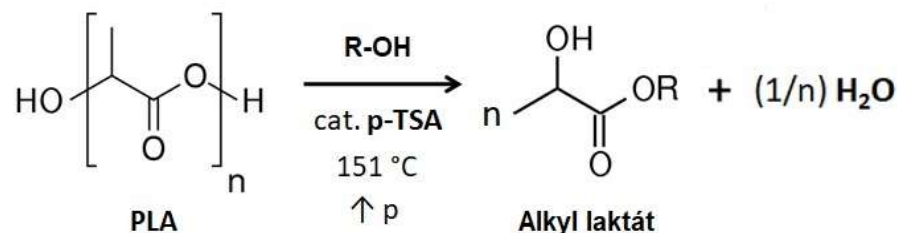


Syntheses of used monomers

1) Depolymerization of biopolyesters



2) Modification of formed monoesters



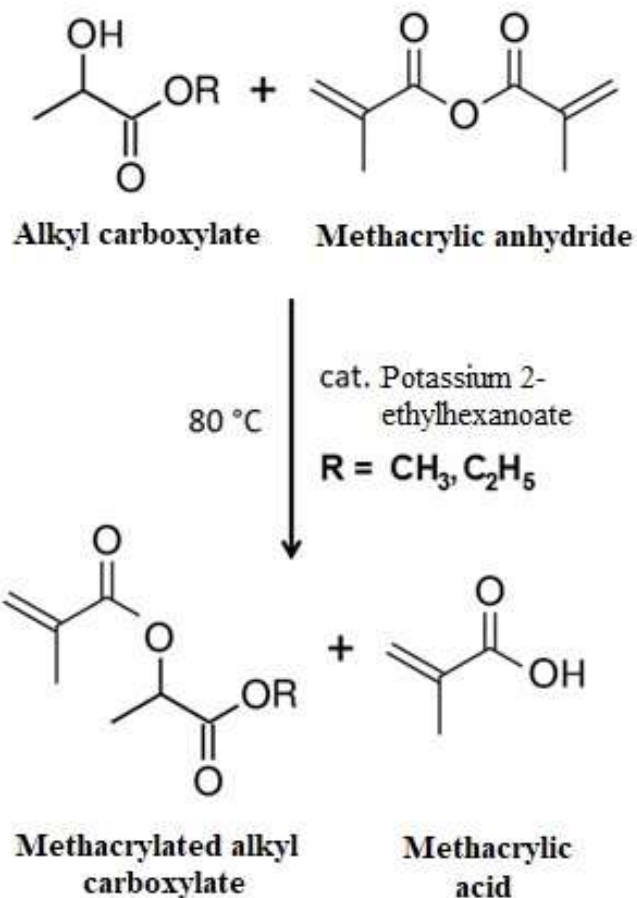


Syntheses of used monomers

1) Depolymerization
of biopolyesters



2) Modification of
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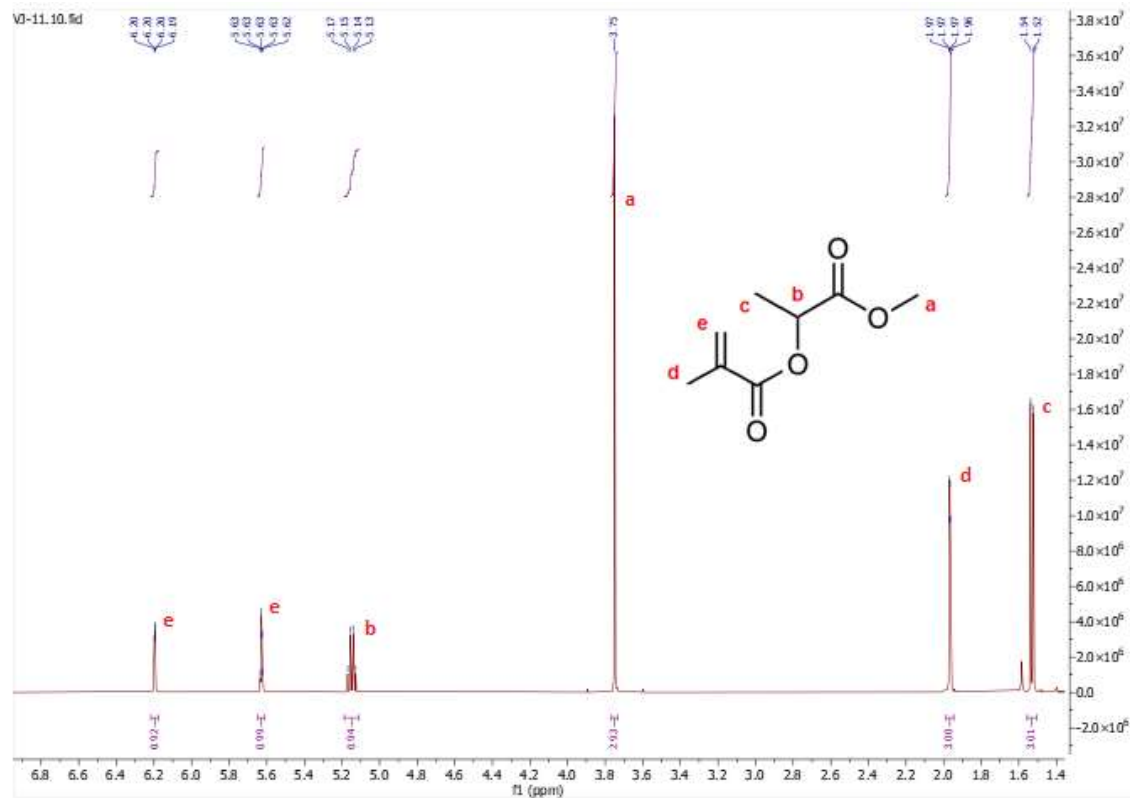




Syntheses of used monomers

Methacrylated alkyl lactates/3-hydroxybutyrates

¹H NMR

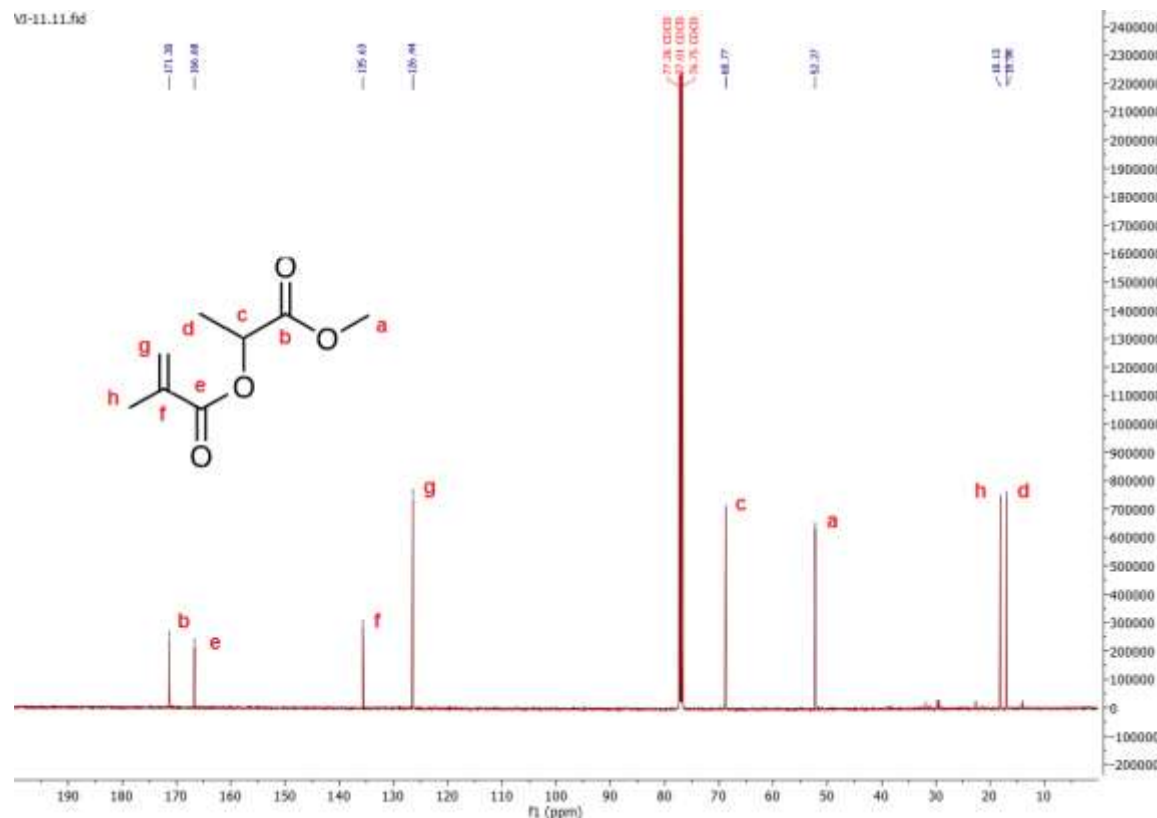
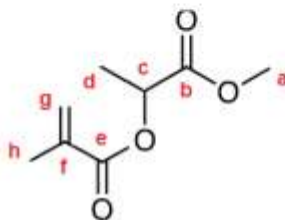




Syntheses of used monomers

Methacrylated alkyl lactates/3-hydroxybutyrates

^{13}C NMR

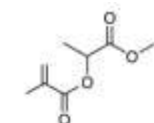




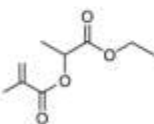
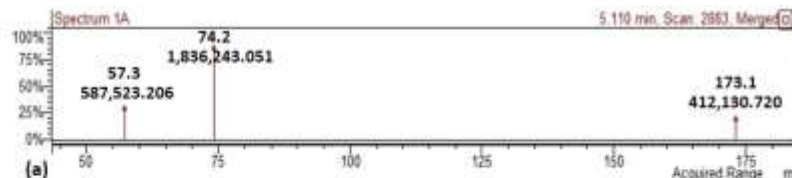
Syntheses of used monomers

Methacrylated alkyl lactates/3-hydroxybutyrates

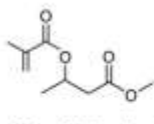
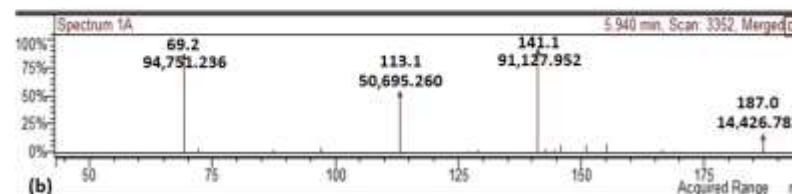
ESI-MS



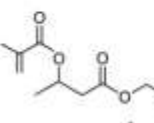
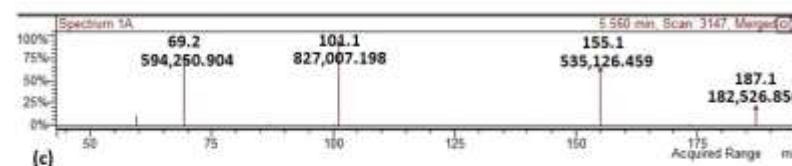
$M_w = 172.2 \text{ g/mol}$



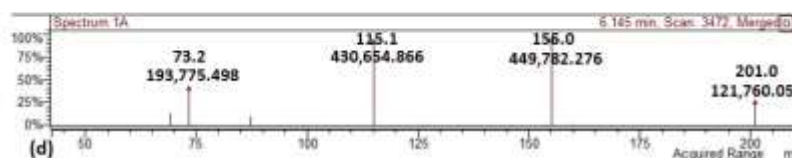
$M_w = 186.2 \text{ g/mol}$



$M_w = 186.2 \text{ g/mol}$



$M_w = 200.2 \text{ g/mol}$

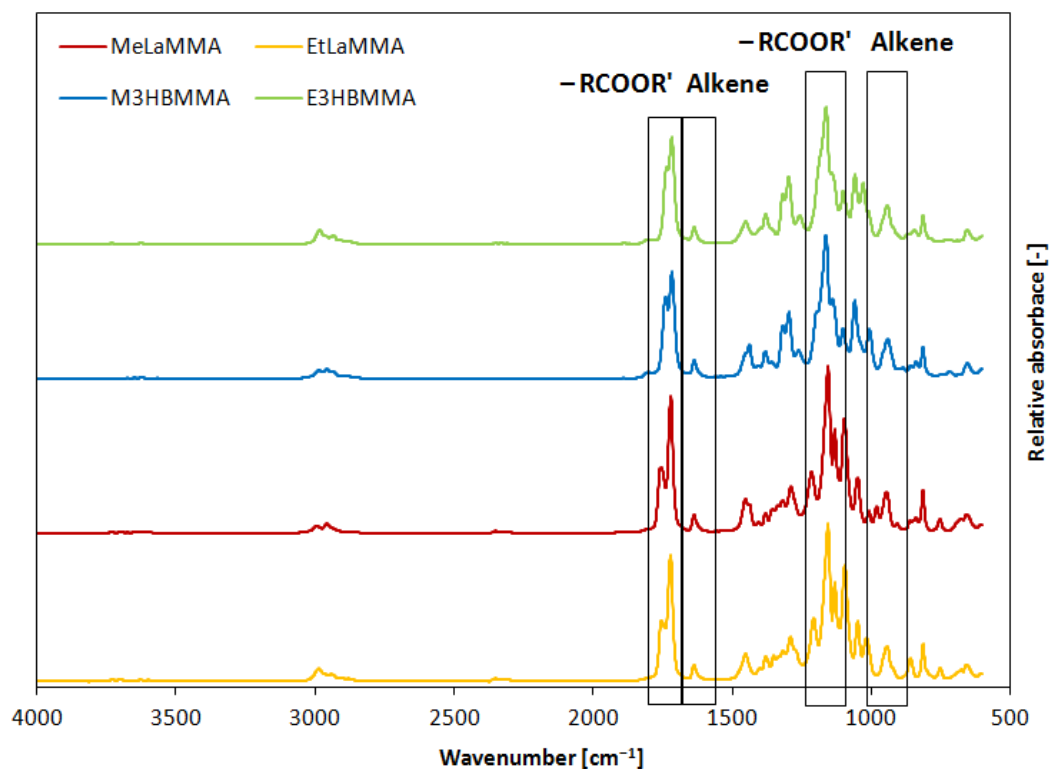




Syntheses of used monomers

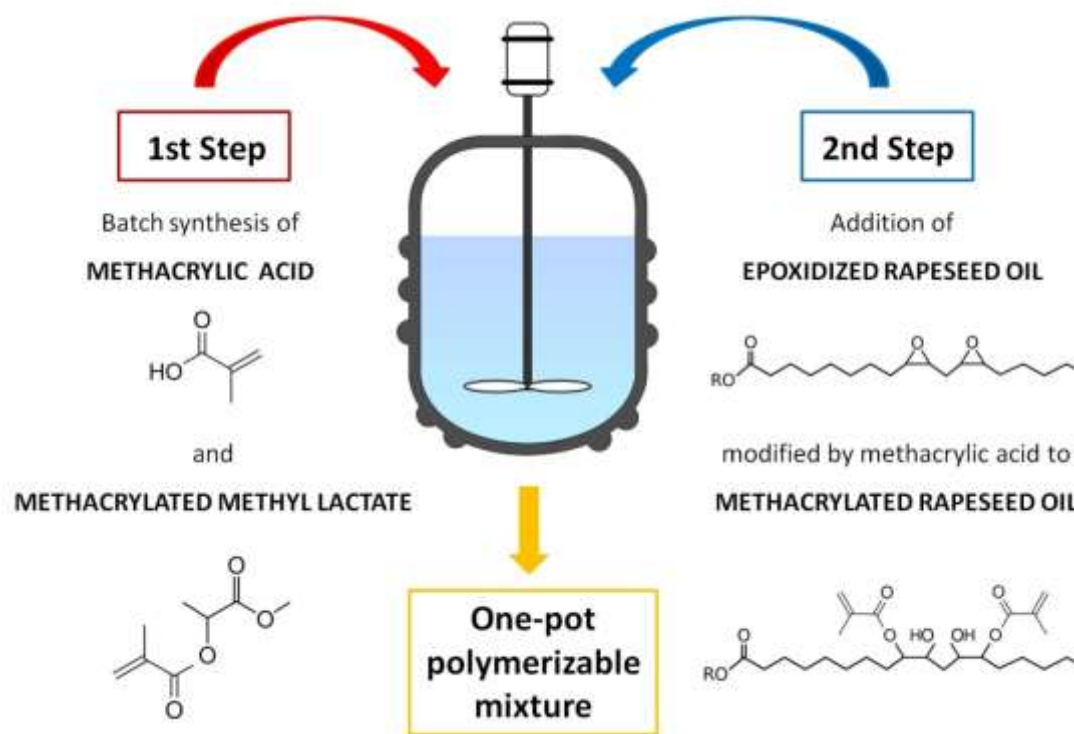
Methacrylated alkyl lactates/3-hydroxybutyrates

FT-IR





Particular suggested material

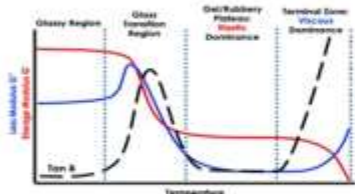




Summarization of **materials usages**

Thermo-mechanical characterization

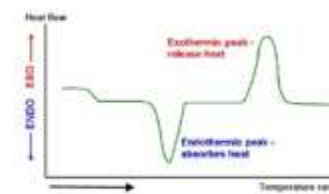
Mechanical properties



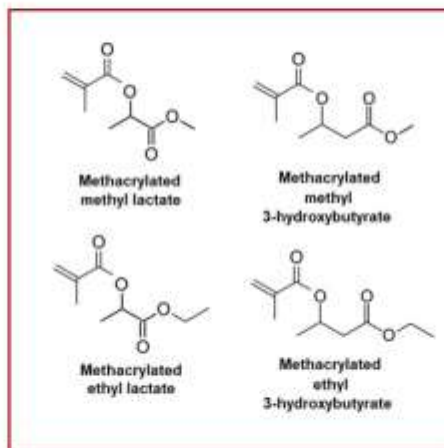
Dynamic mechanical analysis (DMA)

Reactivity

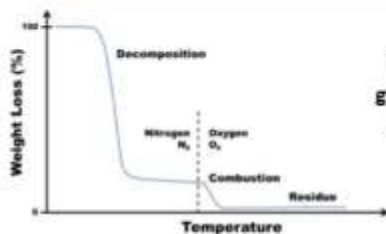
Differential scanning calorimetry (DSC)



Thermo-mechanical characterization of curable **PLA** and **PHB** monomers



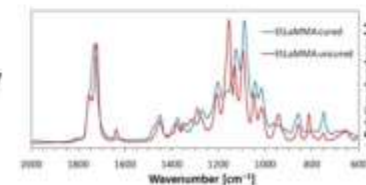
Thermal characterization



Thermal gravimetric analysis (TGA)

Degree of cure

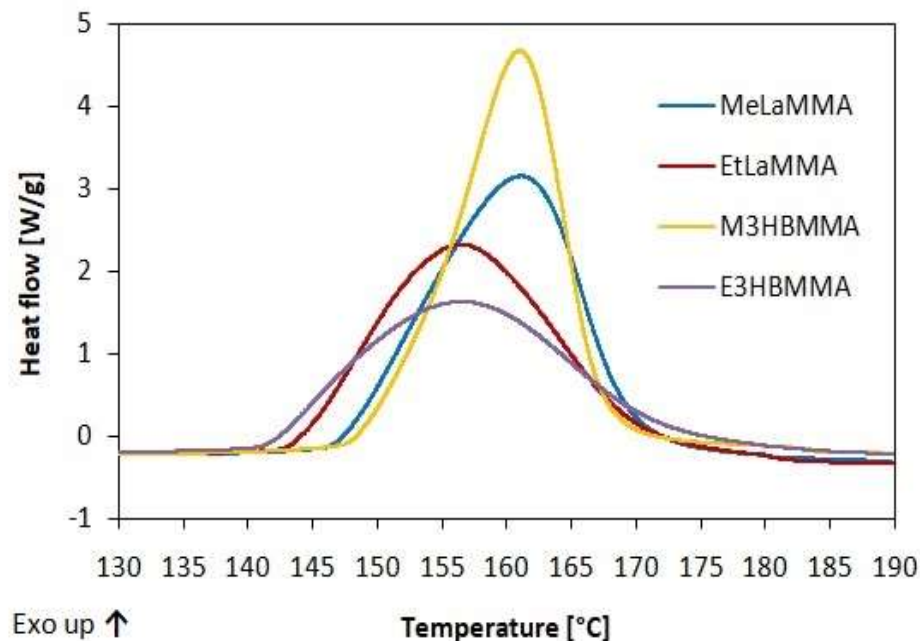
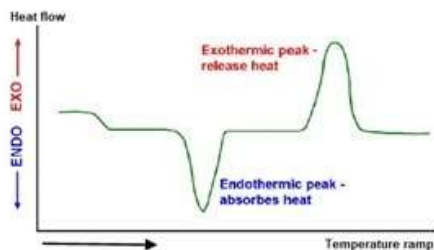
Infrared Spectroscopy (IR)



Thermo-mechanical characterization

Reactivity

Differential scanning calorimetry (DSC)

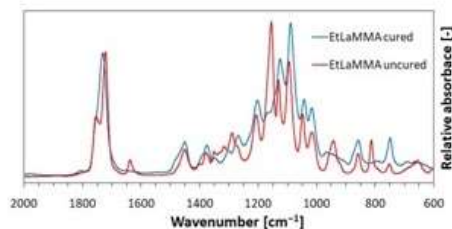




Thermo-mechanical characterization

Degree of cure

Infrared
Spectroscopy
(IR)



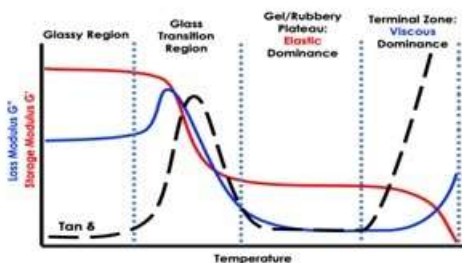
$$DC = \left(1 - \frac{\left(\frac{A_{C=C}}{A_{C=O}} \right)_{cured}}{\left(\frac{A_{C=C}}{A_{C=O}} \right)_{uncured}} \right) \times 100,$$

Fourier-transform infrared spectroscopy (FT-IR) analysis

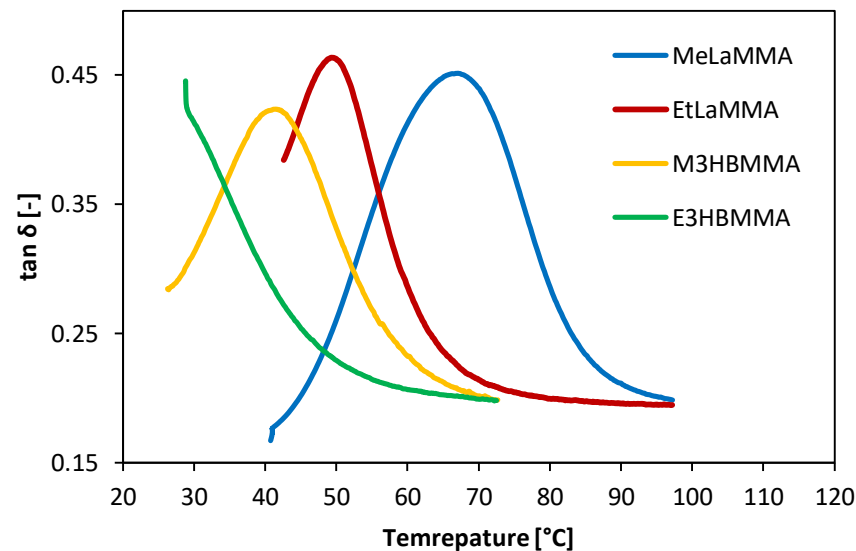
Molecule	Degree of cure (%)
MeLaMMA	95.24
EtLaMMA	96.82
M3HBMMA	72.41
E3HBMMA	69.42

Thermo-mechanical characterization

Mechanical properties



Dynamic
mechanical
analysis
(DMA)

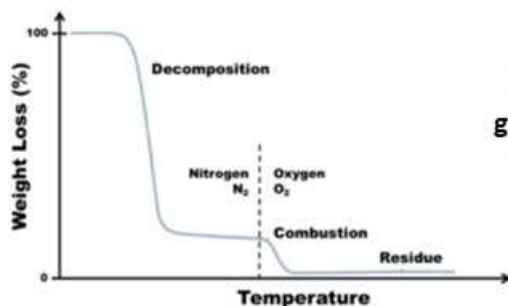


Dynamic mechanical analysis (DMA)

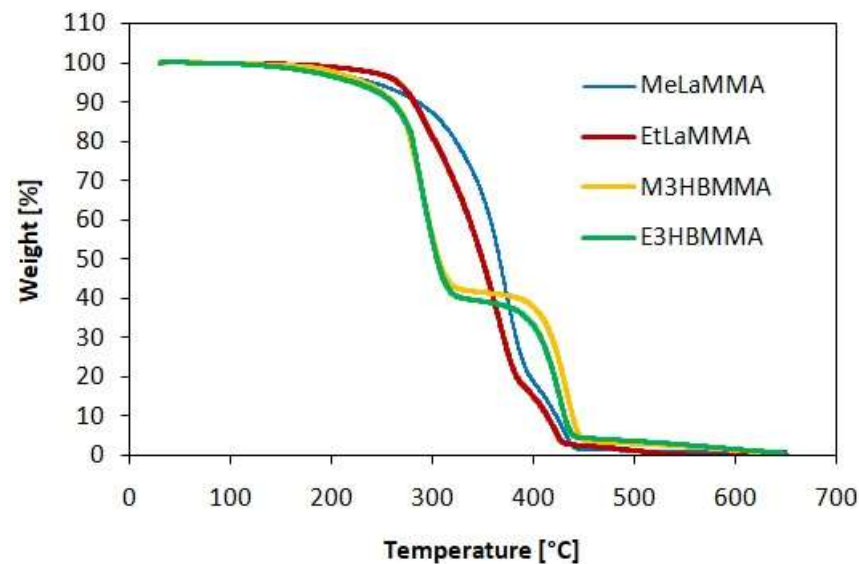
Molecule	Glass transition temperature		Storage modulus $E'_{40^\circ\text{C}}$ (MPa)
	T_g (°C)	T_g (%)	
MeLaMMA	67.1		1844
EtLaMMA	49.4		1111
M3HBMMA	44.4		655
E3HBMMA	< 25.0		614

Thermo-mechanical characterization

Thermal characterization



Thermal
 gravimetric
 analysis
 (TGA)



Thermal gravimetric analysis (TGA)

Molecule	T_5 (°C)	T_{30} (°C)	T_s (-)
MeLaMMA	239.7	343.8	148.0
EtLaMMA	265.5	320.7	146.3
M3HBMMA	231.5	287.5	129.9
E3HBMMA	221.5	287.7	125.1



Particular usage – SLA 3D printing





Thank you very much for your attention!