Master of Science HES-SO in Life Sciences

Light and Material interactions
Toward a bio-based reactive diluent for photopolymerization

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CHEMICAL DEVELOPMENT & PRODUCTION

HEIA-FR

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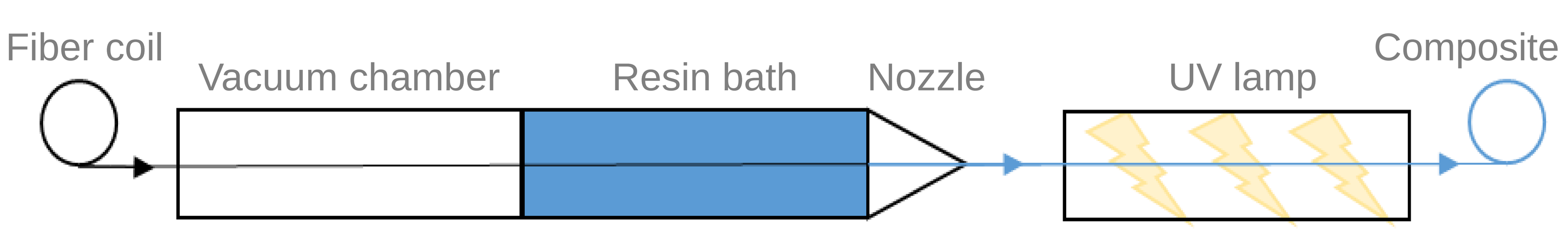
DESCRIPTION

This project is part of Michelin's objective to increase its sustainable material rate to 100% by 2050.

Composite materials offer superior strength and stiffness with low density, making them an ideal choice for building lightweight structures with better performance and lower carbon emissions. However, most composite materials are made from petroleum-based resins, which contribute significantly to greenhouse gas emissions and harm human health.

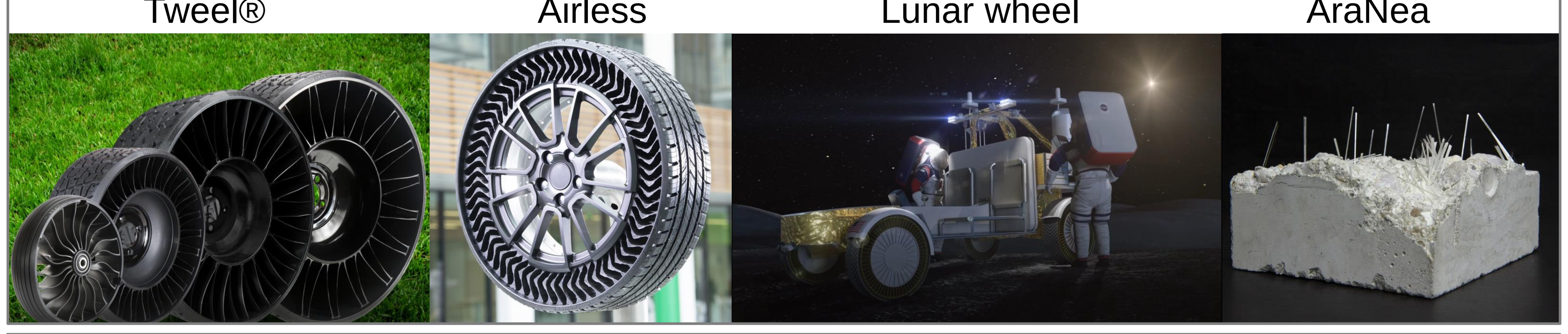
To address this issue, Michelin is undertaking a research project to find a replacement for the non-renewable and potentially harmful compound styrene used in their composites (GFC).



Pultrusion process scheme

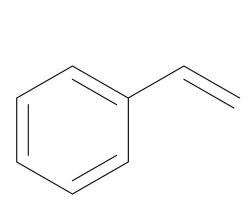
Applications

Tweel® Airless Lunar wheel AraNea

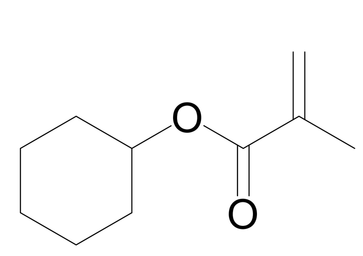


OBJECTIVES

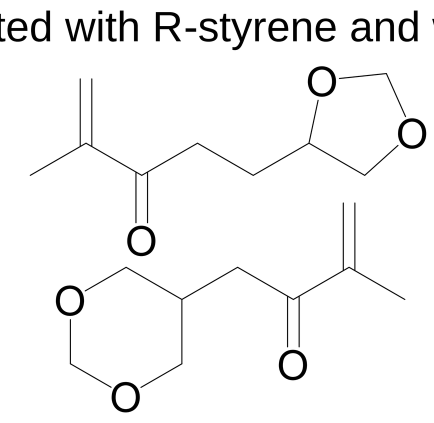
- Identify a separation method to remove the styrene from the oligomer.
- Optimize this process to obtain <1,0 wt% of styrene in the formulation.
- Identify the best bio-based reactive diluent (RD) to replace styrene.
  - Good photo-reactivity
  - High Tg (>180°C)
- Produce and characterize GFC formulated with R-styrene and with the selected RD.



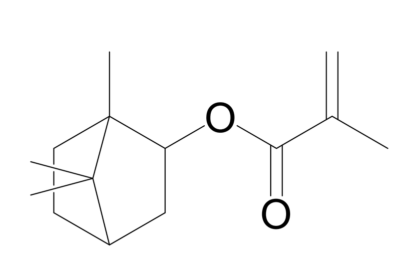
Recycled styrene (R-styrene)



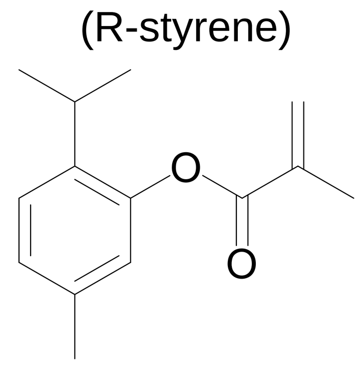
Cyclohexyl MA (CHMA)



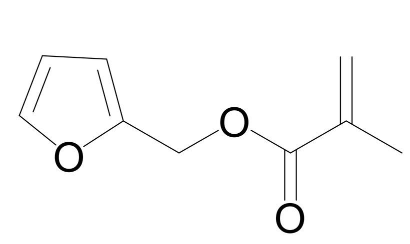
Glycerol Formal MA (Glyfoma)



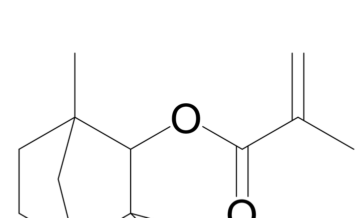
Isobornyl MA (IBOMA)



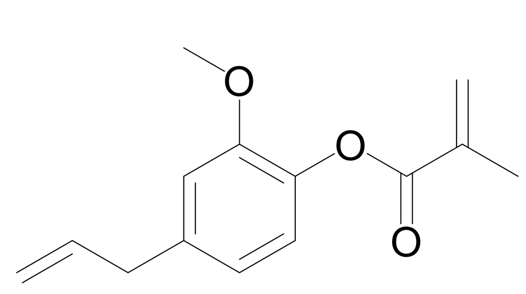
Thymyl MA (TM)



Furfuryl MA (FM)



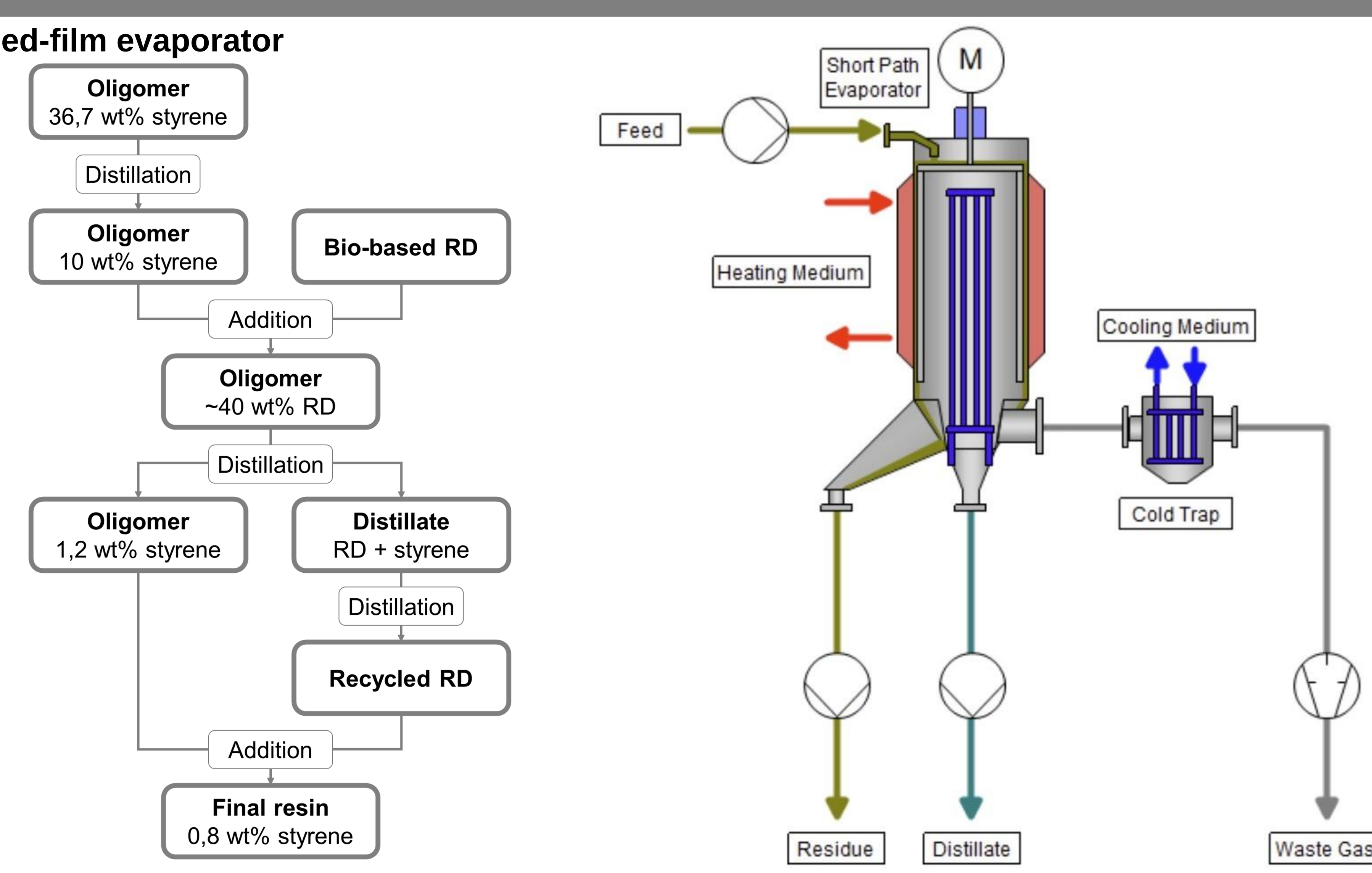
Fenchyl MA (FeM)



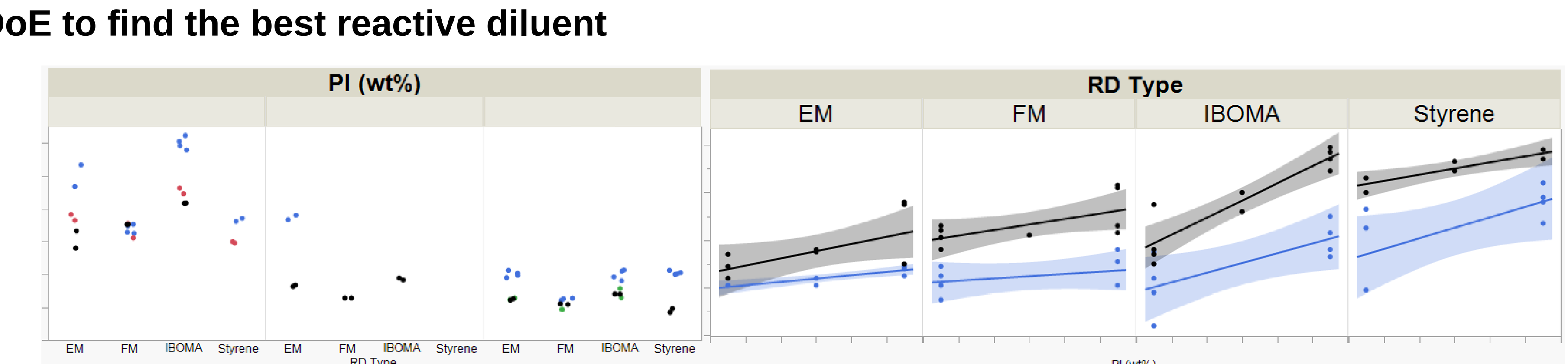
Eugenyl MA (EM)

RESULTS

Wiped-film evaporator

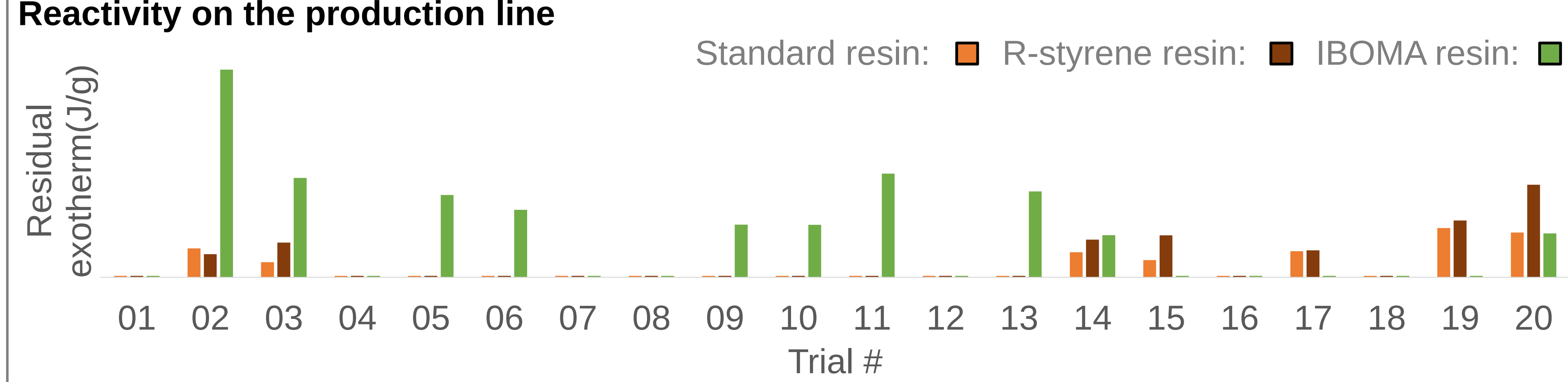


DoE to find the best reactive diluent

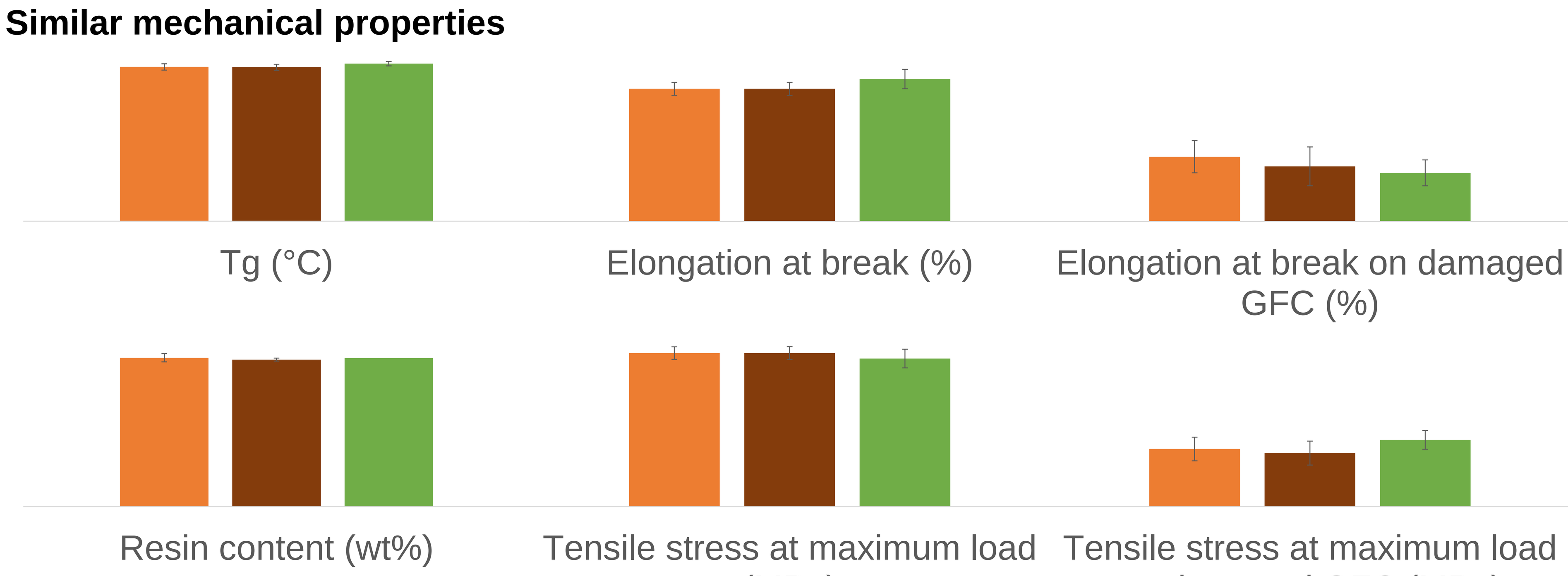


Depth of polymerization comparison Tg comparison

Reactivity on the production line

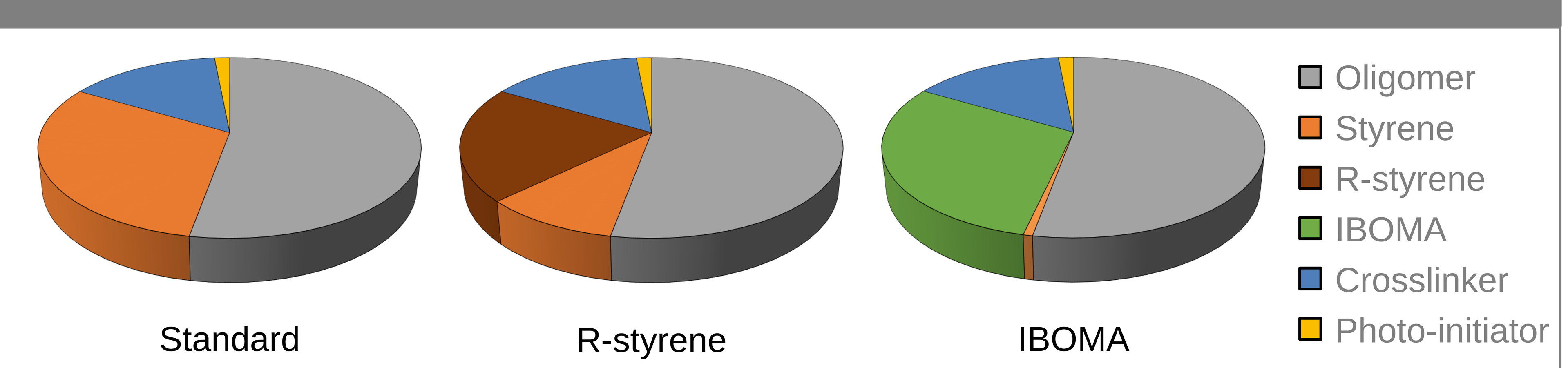


Similar mechanical properties



CONCLUSION

- Distillation with wiped-film evaporator to obtain <1.0 wt% of styrene in formulation.
- R-styrene GFC: similar to standard GFC but only ~2/3 of RD was R-styrene.
- Best resin: IBOMA→ Only Tg over 180 °C.
- IBOMA GFC: comparable mechanical properties to standard GFC but not same reactivity.
- Future work : Research on oligomer, crosslinker and fiber replacement



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