KUNSTSTOFF TECHNIK LEOBEN

Polymer Processing

Otto Glöckel-Straße 2 | A-8700 Leoben | kv@unileoben.ac.at |www.kunststofftechnik.at

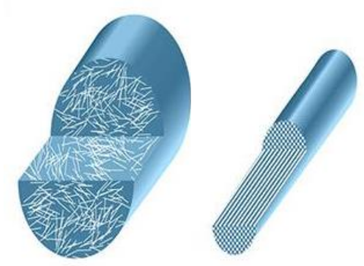
The Effect of Post-industrial Recycled Glass Fiber Flakes on the Rheological Properties of Recycled Polypropylene

Zahra Shahroodi[1], Nina Krempl[1], Clemens Holzer[1]

1 Montanuniversität Leoben, Department Polymer Engineering and Science, Institute of Polymer Processing, Leoben, Austria

Introduction

The market for fiber-reinforced polymers (FRP) and polymer composites, in general, has been steadily growing in the last few years. Despite established production technologies, further progress in lightweight composite construction is increasingly difficult due to unresolved recycling problems, such as the undefined history of each fiber-reinforced composite. Therefore, the development of composite waste recycling and re-manufacturing is increasingly gaining attention [1].



FRP's rheology can be characterized using bulk viscosity and can be described accounting for the structure behavior and its evolution. Numerous studies focused on the viscosity of short fiber-filled polymers and showed that the viscosity increases with fiber content and length. However, recycled FRP, even based on the same polymer matrix and fiber with the same fiber length, has different rheological behavior due to the presence/absence of additives like coupling agents [2].

Objectives

Investigating the compounding process, glass flake content, and flake type of two different post-industrial (PI) shredded composites on the rheological properties of recycled polypropylene (rPP).

Experimental

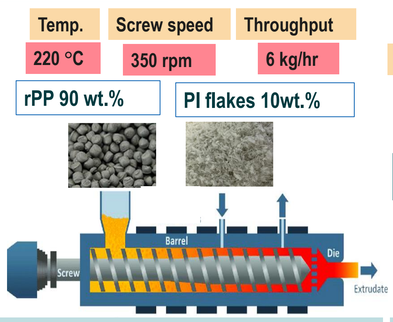
Materials

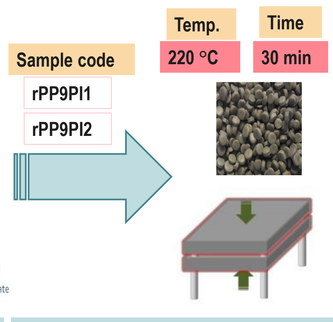
Post consumer recycled polypropylene (rPP)- (Skyplen 04KC0, PreZero, Austria)

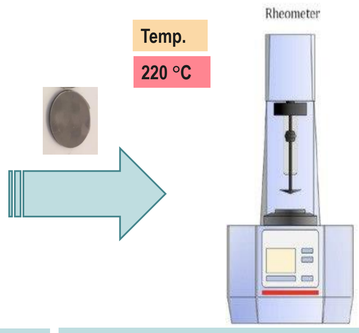
Uni-directional tapes as shredded composite **(PI1) PP, and glass fiber (JKU, Austria)**

Technical shredded composite **(PI2) PP, glass fiber, and PP-g-MA (ENGEL, Austria)**

Methods







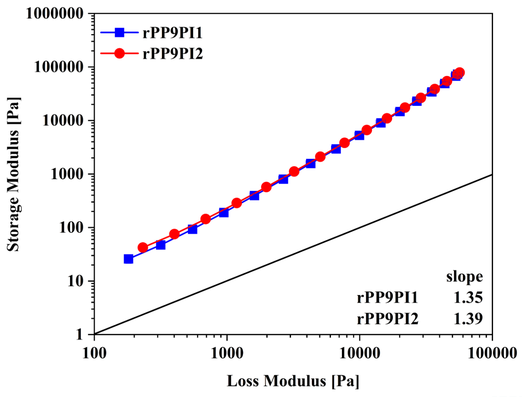
Compounder (ZSE27MAXX-44D, Leistritz Extrusion Technology GmbH, Germany)

Hydraulic Vacuum Press (P200PV, COLLIN Lab & Pilot Solutions GmbH, Germany)

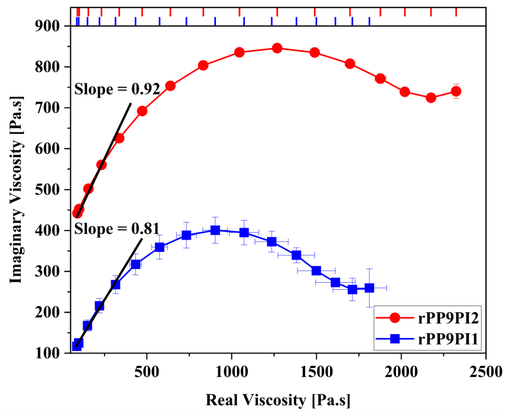
Rotational rheometer (MCR 702 MultiDrive, Anton Paar GmbH, Graz, Austria)

Characterization of rPP/PI composites

Han plot and Cole-Cole plot: Compatibility

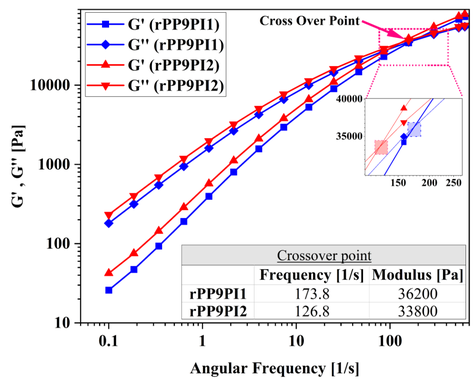


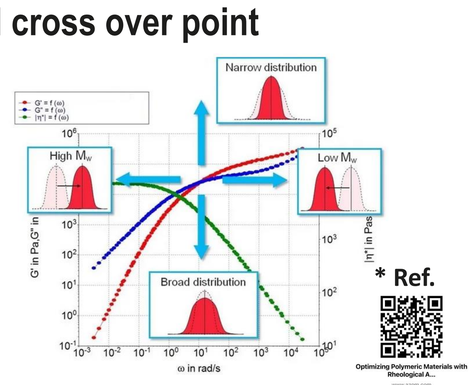
Higher slope in rPP9PI1 reveals more **compatibility** between components.



A smooth semi-circle shape reveals **compatibility**, and **lower slope** shows more **homogeneity** in the sample.

Rheological cross over point

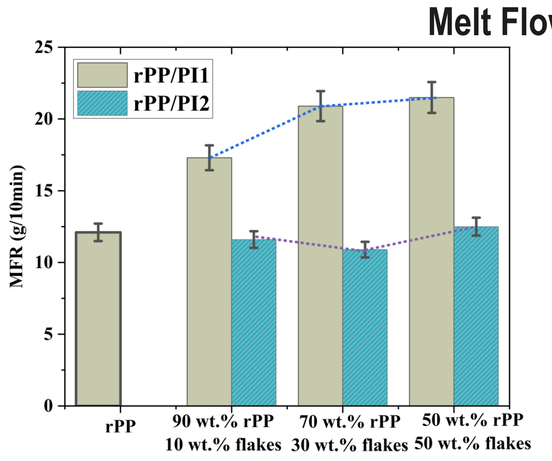




Higher cross over frequency in rPP9PI1 reveals **lower Mw** mainly due to exerted shear during compounding

Effect of fiber content/type on rPP

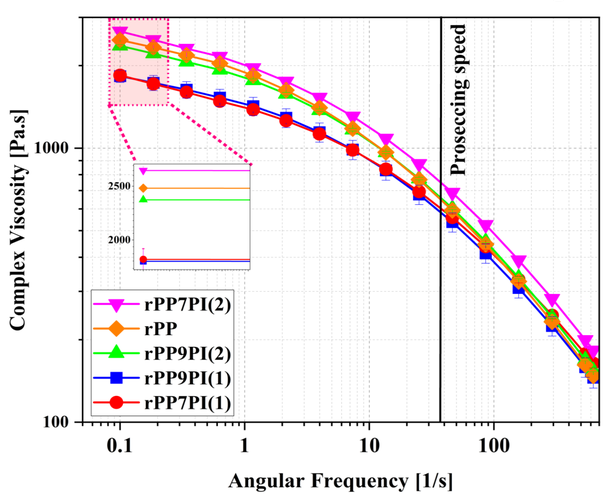
Melt Flow Rate



Adding PI1 to rPP increases MFR, and with increasing flake content MFR increased. This behavior confirms the **degradation during compounding** in the presence of **PI1**.

In rPP9PI2, after adding PI2, MFR was constant, showing **more shear resistance** in **PI2**.

Rheological properties

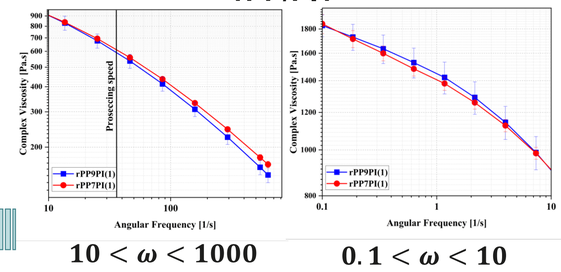


Lower complex viscosity in rPP/PI1 compounds confirms the MFR results about **degradation**.

At the whole frequency range, by increasing PI2, the complex viscosity of compound increases.

By increasing PI1 content, two different behavior was observed in rPP/PI1:

rPP/PI1



$10 < \omega < 1000$

η^* rPP7P1> η^* rPP9PI1

$0.1 < \omega < 10$

η^* rPP9P1> η^* rPP7PI1

At lower frequencies (0.1-10) by increasing PI content, viscosity decreased. Another indication of degradation and confirms MFR results.

Conclusion

10 wt.% of different post-industrial recycled glass fiber composites in the form of flakes was compounded with rPP, and with the aid of Han and Cole-Cole plots, PI2 showed more compatibility with rPP. By checking the rheological cross-over point, it was suggested that the presence of PI1 decreases the molecular weight of rPP. Hence, the effect of PI flakes content on rPP was measured. By increasing PI1 content, more shear was exerted on rPP, resulting in a reduction in Mw. Further, we will investigate probable chain branching in both composites with the aid of rheology.

References

[1] Scaffaro R., et al., Polymers, 13, 3817, **2021.**

[2] Auta H. S., et al., Environmental Science and Pollution Research, **2021**.

SCAN ME!

ZAHRA SHAHROODI

Institute of Polymer Processing

Zahra.shahroodi@unileoben.ac.at

RESEARCH FOCUS:

Mechanical Polymer Recycling,

Injection Molding Compounding, Material Analysis

PROJECT: LightCycle

Funding: Austrian Research Promotion Agency (FFG)

PROJECT PARTNERS:

JKU LIT Factory ENGEL Leistritz GABRIEL-CHEMIE GROUP