10th Student Symposium on Mechanical and Manufacturing Engineering, 2022

Utilization of Recycled Household Waste HDPE and the Effect of Introducing Nexamite R301

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1. Introduction

Post-consumer recycled HDPE (rHDPE) is used in production, but has inferior properties compared to virgin HDPE (vHDPE).
In order to make the properties compatible with vHDPE, a masterbatch, Nexamite R301, has been added, with the intention to increase the mechanical properties and environmental stress crack resistance (ESCR), while decreasing the melt flow rate (MFR). Those changes are usually linked with a crosslinking mechanism.

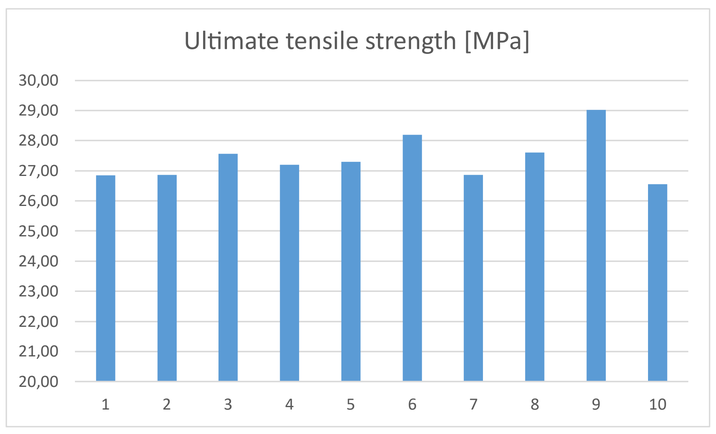
In order to investigate if R301 had the claimed effects on rHDPE, ten mixes with different concentrations of vHDPE, rHDPE and R301 were prepared.

Batch	rHDPE [%]	R301 in rHDPE [%]	vHDPE [%]
1	30	0	70
2	30	1	70
3	30	3	70
4	50	0	50
5	50	1	50
6	50	3	50
7	100	0	0
8	100	1	0
9	100	3	0
10	0	0	100

Mechanical and thermal characterization was performed by tests. Additionally, functional groups present in R301 were analysed in FTIR.

2. Material properties

Tensile test:
When comparing the batches with no additive, batches 1, 7 and 10 showed alike strengths, whereas batch 4 had a slightly higher value. An increase in tensile strength occurred when R301 was added to the batches with both vHDPE and rHDPE.



It was seen, that the more rHDPE and R301 the batch contained, the higher the tensile strength. The biggest influence of R301 was thus seen in batches 8 and 9, which only contained rHDPE.

Rheology:
It was seen, that the molecular weight was increasing when R301 was added.

The lower the x value for crossover point of storage and loss modulus curves, the higher the molecular weight of the sample.

It is known that a high molecular weight is equivalent to a low MFR, R301 decreased the MFR of rHDPE.

Batch	Crossover x value [Hz]
7	0.807
8	0.312
9	0.048
10	0.223
R301	0.340

DSC:
A significant decrease in the degree of crystallinity was seen, when the concentration of R301 was increased for batches 1-3 and 4-6.

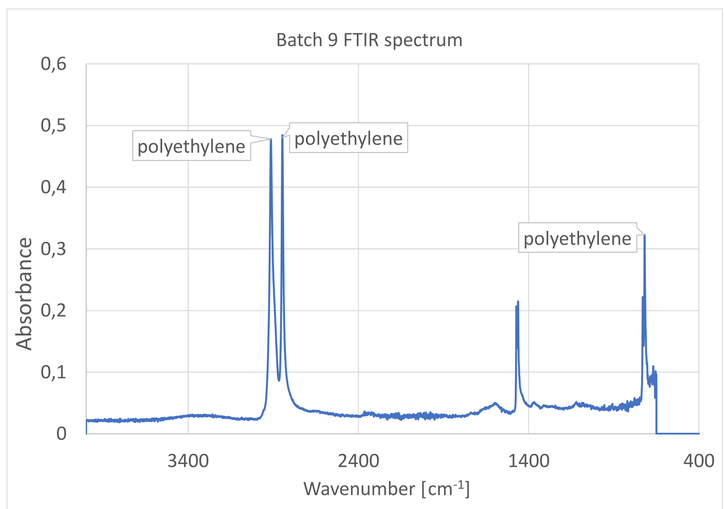
The decrease in degree of crystallinity corresponds to more crosslinking, as it hinders crystalline lamellae to form, due to disorder and decreased chain mobility.

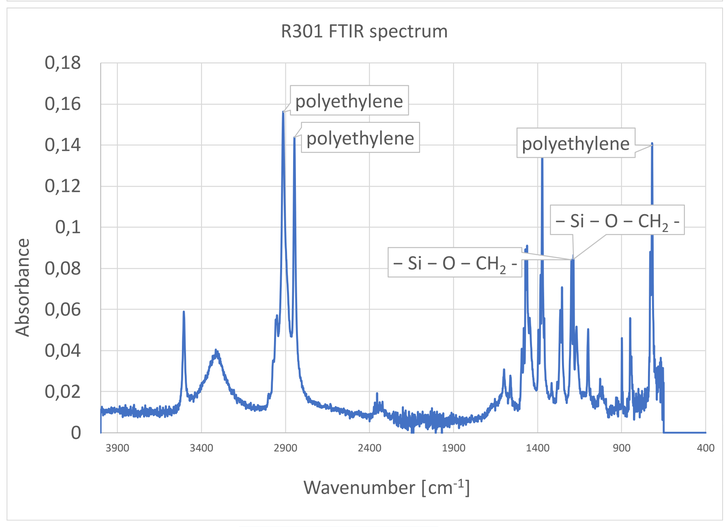
Batch	T_m [°C]	2. X_C[%]
1	131.94	60.57
2	130.82	57.37
3	137.83	53.95
4	131.63	62.35
5	131.42	62.57
6	131.91	62.65
7	134.82	59.34
8	132.52	58.41
9	137.19	51.23
10	134.68	57.37
R301	112.42	28.30

3. FTIR characterization

FTIR:
Characteristic peaks for polyethylene are at approx. 2915, 2848 and 725 cm^{-1}. Those were visible for batches 1-10 and R301.

Additionally, spectrum acquired for R301 showed two peaks at approx. 1198 and 1186 cm^{-1}. Those could indicate the presence of Si-alkoxy compound in the additive. As siloxanes are used to crosslink HDPE, such a peak appearing in R301's spectrum points to it being a crosslinking agent.





4. Conclusions

The addition of Nexamite R301 decereased the MFR of rHDPE and improved the tensile strength, which validates what was claimed by the producer.

The DSC measurements showed a decrease in degree of crystallinity, while FTIR showed presence of a siloxane group. Both are indicators of R301 being a crosslinking agent, as crosslinking hinders a crystalline structure, while siloxane is used as a crosslinking agent.

ESCR was not tested in this study due to various complications.

Acknowledgement

The authors of this work gratefully acknowledge Grundfos for sponsoring the 10th MechMan Symposium