Development of basalt fiber-reinforced polymer compounds for lightweight construction applications (“BasaProp”)

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Motivation

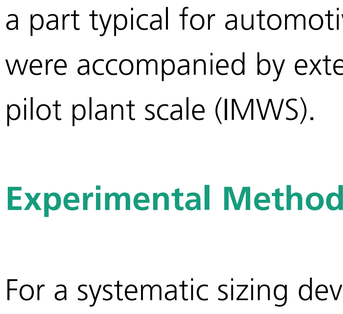
Basalt fibers made from basic lava rock are a technically and economically interesting alternative to glass fibers. Due to the raw materials, basalt fibers are more energy-saving and environmentally friendly to produce than the common E-glass fibers. With only about 5% higher density than E-glass fibers, basalt fibers had up to 15% higher values of tensile strength and stiffness as well as high thermal and chemical resistance. However, due to its current poor sizing adhesion to polyolefin-based matrices, the good potential of basalt fibers as reinforcement in thermoplastic compounds has not yet been fully exploited [1-3].
Therefore, the aim of the project was to develop a basalt fiber reinforced polypropylene composite with improved mechanical properties as a substitute for conventional glass fiber composites.

Involved Partners and Work Packages

In order to improve the compound properties and to demonstrate the potential of basalt fibers for innovative applications, Deutsche Basalt Fiber GmbH (DBF), Polyram MCT Germany GmbH, SLM Kunststofftechnik GmbH and Fraunhofer IMWS have formed the joint project “BasaProp”. The focus of the project was on the basalt fiber and sizing optimization for the chopped fiber assembly (DBF), the development of basalt fiber reinforced polypropylene compounds (MCT) and the injection molding of a part typical for automotive outdoor applications (SLM). The material developments were accompanied by extensive material-technical investigations on a laboratory and pilot plant scale (IMWS).

Experimental Methodology and Results

For a systematic sizing development, a methodology was developed to assess the fiber-matrix-interaction in fiber reinforced compounds. It could be proven that the storage modulus of a DMA analysis is a sensitive parameter which allows a quantitative assessment of different sizings based on mini samples (“chips”) made by lab scale compounding equipment. As a result, optimum sizings could be identified for different matrix polymers.
After this a sizing process was developed which allowed to produce chopped fibers in an amount sufficient for an upscaling of the compounding process.
An optimum compounding process for the chopped basalt fibers was developed, samples for injection molding were produced.
An optimum injection molding process was developed. A demonstrator part made from basalt fiber reinforced polypropylene was developed.



Left image: REM image of a basalt fiber with a sizing with bad film forming capacity
Middle image: REM image of a basalt fiber with a sizing with good film forming capacity
Right image: Chips for DMA made with lab scale compounding and injection molding equipment

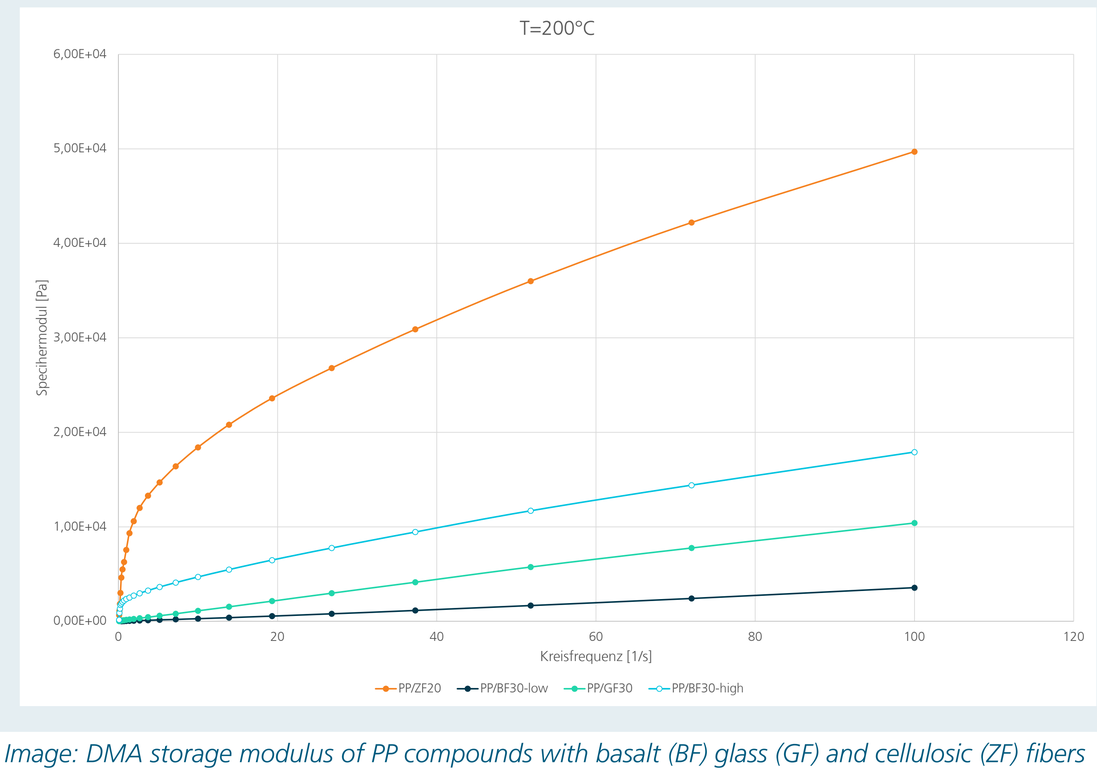
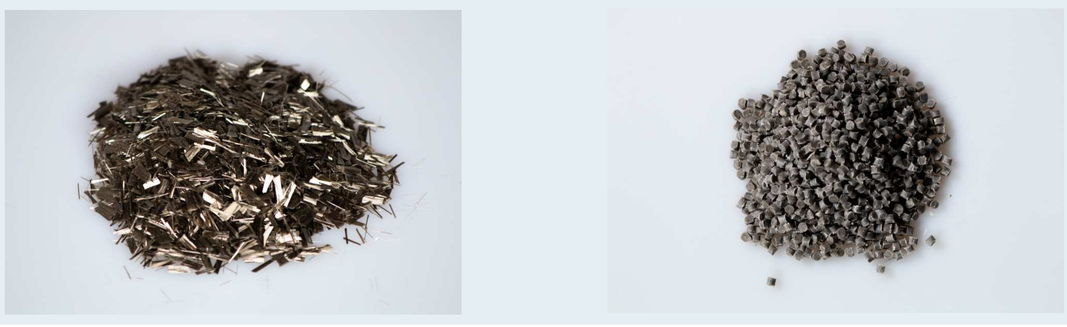


Image: DMA storage modulus of PP compounds with basalt (BF) glass (GF) and cellulosic (ZF) fibers



Left image: Chopped basalt fibers with optimum sizing
Right image: basalt fiber – polypropylene pellets

Image Injection molded trims for automotive outdoor applications made of basalt fiber reinforced PP

Summary & Outlook

- Chopped basalt fibers with sizings suitable for thermoplastic compounds could successfully be developed.
- Compound recipes and an efficient compounding technology for injection moldable compounds are available.
- A injection molded trim was made from a basalt fiber reinforced polypropylene which demonstrates the suitability for automotive outdoor applications.

Acknowledgement

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DBF Deutsche Basalt Faser GmbH · Polyram MCT Germany · SLM Kunststofftechnik GmbH