HIGH IMPACT MODIFICATION OF PLA WITH NATURAL RUBBER AND THE INFLUENCE OF FIBER CONTENT, FIBER LENGTH ON THE IMPACT STRENGTH OF PLA-FLAX-NATURAL RUBBER COMPOSITES.

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INTRODUCTION

Poly-(lactic acid) is a versatile polymer, which is fully biodegradable and can be processed similar to polyolefins. It has good mechanical properties e.g. high stiffness and high tensile strength combined with optical good properties (transparency) that makes PLA attractive for many packing and household applications. In order to make PLA also feasible for automotive industry and other high performance markets new composites have to be developed to overcome the low thermal stability and improve toughness. Different attempts with reinforcements like jute[1], microcrystalline cellulose (MCC)[2] or flax[3] have been made to improve mechanical properties such as tensile modulus.
The goal of this study was to improve the impact strength properties of PLA by varying the natural rubber content and flax content as well as processing parameters e.g. rotational speed and flow rate in a parallel twin screw extruder.

RESULTS

PLA –compounds with a natural rubber (NR) content of 5%, 10% 15% and 20% were created in a parallel twin-screw extruder and mechanically tested according to ISO standards for composites and plastic. The results were plotted in a diagram Charpy impact strength versus Young's modulus to summarize the mechanical properties. Dependent on the natural rubber content and flow rate the toughness of PLA was increased by almost a factor of four (Charpy impact strength 80kJ/m^2), while the Young's modulus was hardly affected. In a further attempt to combine of the good impact properties of natural rubber with a high modulus modification with flax fibres, compounds of different fibre content and natural rubber content were prepared. Fibre lengths of 4mm and 8mm were used and the fibre content was varied between 10% and 30%, the natural rubber content between 5% and 30% and the processing parameters e.g. flow rate in the range between 10kg/h and 20kg/h. The impact behaviour of the PLA-NR-Flax compounds decreased for all recipes resulting in values comparable to unmodified PLA-Flax compounds. An overview of the mechanical properties of the measurement series compared with the neat PLA and natural fibre reinforced composites is given in Figure 1. The mechanically requirements for chosen industrial applications are indicated by the squared area (Emodul>2GPa, Charpy>50kJ/m^2).

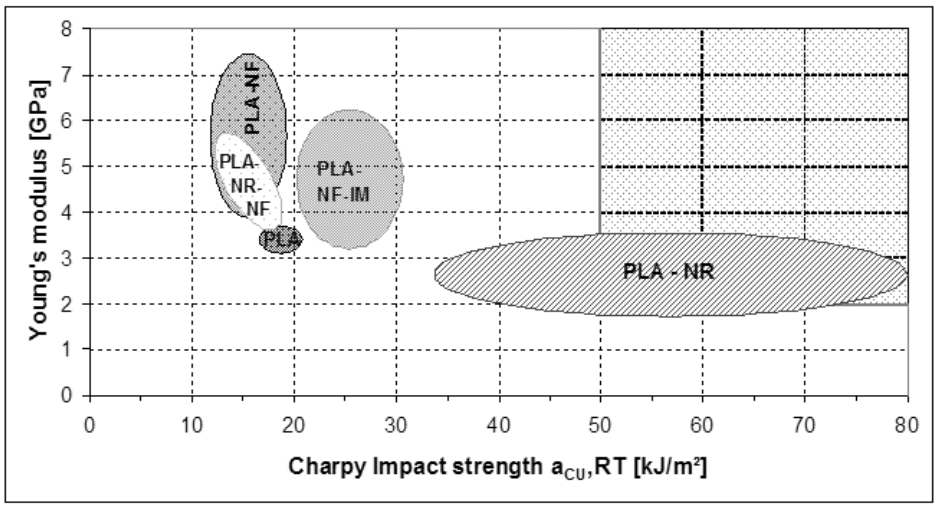

Fig. 1: Overview of the mechanical data of selected PLA composites

A comparison of SEM pictures between PLA-Flax, PLA-IM(petrol based impact modifier)-Flax and PLA-NR-Flax compounds reveal that the decrease of toughness in PLA-NR-Flax compound is not due to poor adhesion between the matrix and the fibre but fibre break since the PLA-IM-Flax compound shows less adhesion but better performance in Impact behaviour.

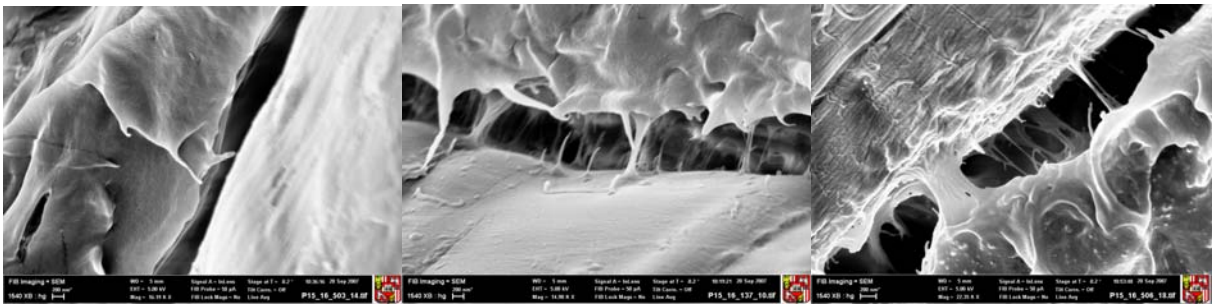

Fig. 2: SEM micrographs of a PLA-NR compound (left), a PLA-IM-Flax compound (center) and a PLA-NR-Flax compound (righ)t

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