Experimental investigation of the forming process of ultra-stiff CFRP from thin tapes

Graduate

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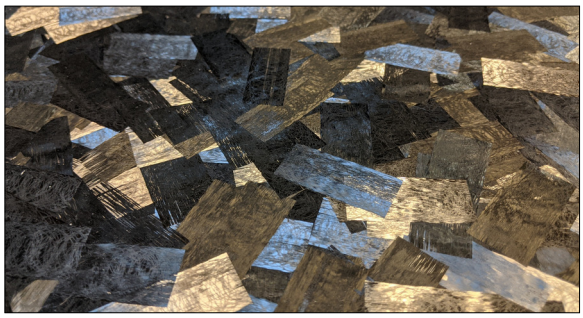
Initial Situation: In industry, there is an increasing demand of fibre reinforced composites. These materials exhibit an excellent strength- and stiffness-to-weight ratio and therefore often the first choice when it comes to light-weight structures. Especially the transport industry is interested in lighter products in order to reduce fuel consumption and environmental impact. Beside the good mechanical properties, fibre reinforced composites have several disadvantages. The design of optimal parts is complex and the manufacturing process is time and cost intensive. For this reason the fibre reinforced composites are not suitable for high-volume production. This increasing demand and the difficulties promote the development of new materials which are interesting for the entire industry and a wide range of products.
One of this new developments is a tape based discontinuous material which consists of randomly oriented ultra-thin prepreg tapes made of carbon fibre. Previous investigations have shown that this material is suitable for high-volume production and has good mechanical properties. In a project at KTH, this material is currently under investigation for its suitability to be used in a foot prosthesis. The main focus of the project is to investigate the fatigue damage resistance and the production process of parts. As it is a new material concept, no investigations have been carried out regarding the forming process.

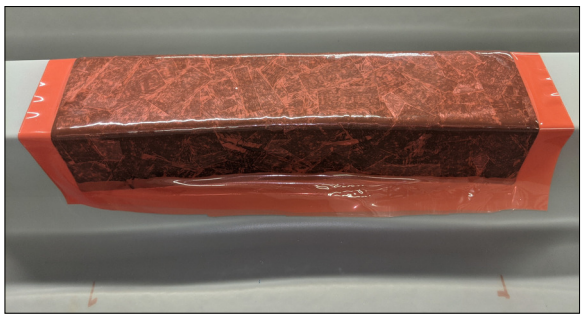
Definition of Task: The goal of this Master's thesis is to experimentally investigate the forming process with this new material. The material structure is different to common fibre reinforced composites and no information about the forming behaviour is available. Based on literature, suitable testing methods should be identified to build up an understanding of the forming behaviour. Based on this tests, a suitable forming process should be defined and its parameters and limitations identified.

Result: Early investigations have shown, that the material behaves more like a common prepreg than a sheet mould compound (SMC). For this reason similar testing methods to those used for the characterisation of prepregs are used in this thesis. The tests carried out are, friction, bending and tensile. The tape itself shows uniform characteristics. However, the material with the randomly distributed tape pieces shows not equally uniform characteristics in an uncured state. It has highly location dependent stiffnesses and strengths which are overall low at elevated temperature. It is also shown that further investigations are needed to completely characterise the material and to be able to build up an FE-simulation.
The testing has shown that the material must be supported during the entire forming process and an applied normal pressure is advantageous. Based on this findings, the double diaphragm forming process is found to be suitable. Several trails are carried out in order to optimise this process. The material and the process show to be suitable and parts have been formed. The remaining difficulties concern the available equipment and suggestions for further improvement are provided. In this thesis a suitable forming process and testing methods for this new material are shown. As this were the first investigations several improvements and further investigations are proposed.

Structure of investigated material TeXtreme® thin-ply SMC
Own presentment



Material covered with release film after the double diaphragm forming process
Own presentment



Cured part
Own presentment

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Subject Area
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