Gummi för fordonsapplikationer framställt av skogsindustriavfall

Public report

Project within: Accelerate Swedish Partnership
Author: Martin Bellander, Scania CV AB
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FFI
Fordonsstrategisk
Forskning och
Innovation

Content

FFI in short

FFI, Strategic Vehicle Research and Innovation, is a joint program between the state and the automotive industry running since 2009. FFI promotes and finances research and innovation to sustainable road transport.

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1. Summary

Today, the only biobased rubber material used in larger scale is natural rubber. Reselo AB have invented a way to make a useful rubber polymer of the substance suberin, found in birch bark. This is something completely new, giving a unique opportunity to produce a new class of rubber from a biobased source. This project has focussed on characterization of the properties of Reselo Rubber and its mixes together with other rubber polymers. It has shown that the properties are in the range of already existing fossil-based rubber materials, thereby facilitating the replacement of them in existing products. LCA analysis have been performed showing that the Reselo Rubber largely contributes to lower the carbon footprint of the final rubber material but also pointing towards the importance of all the other ingredients in a rubber material, such as carbon black and plasticizer. Finally, real prototypes were manufactured based on Reselo Rubber material. The parts were produced using injection moulding in regular production machinery. This shows upon the possibilities to use this biobased rubber material in large scale in real applications.

2. Sammanfattning på svenska

Det enda biobaserade gummimaterialet som idag används i väsentlig omfattning är naturgummi. Reselo AB har uppfunnit ett sätt att tillverka en användbar gummipolymer av ämnet suberin som finns i björkbark. Detta är något helt nytt som ger en unik möjlighet att producera en ny klass av gummimaterial, och dessutom från en biobaserad källa. Detta projekt har fokuserat på att karaktärisera egenskaperna hos ”Reselo Rubber” och dess blandningar tillsammans med andra gummipolymerer. Det har visat sig att egenskaperna ligger inom samma intervall som redan befintliga fossilbaserade gummimaterial, vilket möjliggör det som ersättning i befintliga produkter. LCA-analyser har utförts. De visar att ”Reselo Rubber” bidrar till att minska koldioxidavtrycket hos det slutliga gummimaterialet, men även betydelsen av alla andra ingredienser i ett gummimaterial, såsom kimrök och mjukgörare. Slutligen tillverkades riktiga prototyper baserade på ”Reselo Rubber”. De producerades med hjälp av formsprutning i vanliga produktionsmaskiner. Detta visar på möjligheterna att använda detta biobaserade gummimaterial i stor skala i verkliga applikationer.

3. Background

Today, the only biobased rubber material used in larger scale is natural rubber, which has been used in an industrial way since mid-1800 when the vulcanisation process was invented. Around 45-50% of the global consumption of rubber today is natural rubber. One of the largest applications for natural rubber is tyres, and truck and heavy-duty tyres

are a big contributor to this. Natural rubber is mainly produced from the rubber tree hevea brailiensis. There are other species that also produces polyisoprene (natural rubber polymer) such as dandelion and guayule but not to any commercial significant amount. Natural rubber has some beneficial properties, such as mechanical strength and good damping properties. However, there are properties that are really poor, such as oil, temperature and weather resistance.
Reselo AB have invented a way to make a useful rubber polymer of the substance suberin, found in birch bark. This is something completely new, giving a unique opportunity to produce a new class of rubber from a biobased source. The resulting polymer is of polyester type, where the monomers are mono- and dicarboxylic fatty acids, having a chain length of C10 to C30. This means that the polymer will have both hydrophilic and hydrophobic parts, and will be different from natural rubber, which is hydrophobic, opening for the possibilities to replace other applications not being able to be replaced by biobased materials hitherto.
Scania and Reselo have been running a one-year project with the aim to evaluate "Reselo rubber" and make prototypes in this novel material. The project has been financed by Vinnova and Scania within the program Accelerated Startup. Rubber manufacturer AnVa Polytech was connected as a partner to the project. With this setup, the whole value chain from raw material to final product was covered.

4. Purpose, research questions and method

The purpose with the project was to learn more about the material, with the main questions to reveal strength and weaknesses and thereby identify possible applications for parts made in Reselo Rubber. The methods used have been both quantitative and qualitative. Experiments have been performed where properties of the material have been measured. The results and observations have also been interpreted in a more qualitative way, trying to understand the behaviour of the new material in a better way.

5. Objective

The objectives in the project have been:

- Characterization of the new material.
- Material specification for a selected target product.
- Make prototypes in the new material, tested in lab.
- A cost estimation/quotation on parts intended for serial production.
- A sustainability comparison vs material used today in the selected product.

6. Results and deliverables

Three different materials have been examined, one based on 100% Reselo Rubber, one mixed with EPDM rubber and one mixed with NBR rubber. All materials contained carbon black as filler.
Basic rubber properties have been investigated, such as tensile strength, elongation at break, hardness, thermal ageing, compression set, oil resistance and low temperature behaviour.
The hardness of the materials was in the range between 61 IRHD and 75 IRHD. The tensile strength of the materials was in the range of 8 to 11 MPa, which is regarded as rather good values. The oil resistance was found to be moderate, with a volume swell of 30% after 72 h exposure to IRM903 oil at 100°C. The corresponding volume swell of the mix with EPDM rubber was 65%, which shows that the Reselo Rubber clearly improves the oil resistance of EPDM rubber.
The thermal ageing behaviour shows that the max usage temperature is in the range of 100°C. After 168 h at that temperature the Reselo Rubber loses 40% of the elongation at break and the compression set is ~70%. When mixing with EPDM or NBR, these figures are improved.
The low temperature behaviour of the Reselo Rubber is somewhat peculiar. The glass transition temperature was determined using DSC (Differential Scanning Calorimetry). Values between -5°C to -10°C were obtained. This is a rather high value to be a rubber material. However, when evaluating the stiffness at low temperatures, it becomes obvious that the transition to a glassy material takes place over a large temperature interval. Thus, even at -20°C, the material is still possible to deform without breaking. This is probably due to the big variation of the structure and size of the monomers present in the polymer.

An LCA-analysis was performed, focussing on the carbon footprint of the material (CO_2-equivalents). The boundaries were cradle to gate for the rubber material (before vulcanization) and the IPCC 2021 GWP100 method was used. The outcome is that the CO2 footprint is clearly lower using the Reselo Rubber. But it does not approach zero values, since there is a certain contribution from the other ingredients in the rubber material, particularly the contribution from the carbon black and the plasticizer.
This shows the importance of having a holistic view when working with sustainability and carbon footprint of rubber materials.

Finally, prototypes were produced using injection moulding. Two different parts were selected, one grommet for cables and one small mat used in the cup holder in a truck cab.

All objectives setup in the beginning of the project have been met and delivered according to plan. The results have increased the knowledge about this novel rubber material and its performance. Together with the successful manufacturing of final parts, this will contribute to the possibilities to use this biobased rubber material in large scale in real applications. The LCA-analysis performed has showed how important it is to have a holistic view when designing new rubber materials with lower carbon footprint.

7. Dissemination and publications

7.1 Dissemination

How are the project results planned to be used and disseminated?	Mark with X	Comment
Increase knowledge in the field	X	
Be passed on to other advanced technological development projects	X	
Be passed on to product development projects	X	
Introduced on the market		
Used in investigations / regulatory / licensing / political decisions		

7.2 Publications

No publications have been made during the project time.

8. Conclusions and future research

The main conclusion is that the Reselo Rubber, a novel and 100% bio-based polymer, can be used for production of rubber parts used in e.g. automotive applications.
There is some additional work needed to make parts in serial production, such as development of the mixing procedures and scale up of the production. Further characterization of the material and optimization of different rubber formulations will also be needed.

9. Participating parties and contact persons

Scania CV AB – Martin Bellander, Materials Technology.

Reselo AB – Caroline Grimler, Project Manager.

External partner connected the project: AnVa Polytech – Erik Hilmersson.