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Electric vehicle user-centric design for optimised energy efficiency

GRANT AGREEMENT No. 769902

DOMUS

Design OptiMisation for efficient electric vehicles based on a USer-centric approach

DOMUS – Deliverable Report

<< D3.6 Advanced surfaces to reduce heat generation and Report describing why, how and what >>

Deliverable No.	DOMUS D3.6	
Related WP	WP 3	
Deliverable Title	Advanced surfaces to reduce heat generation and Report describing why, how and what	
Deliverable Date	2021-01-31	
Deliverable Type	REPORT on development on optimized body panels with respect to improved heat capacity and processability	
Dissemination level	Confidential – member only (CO)	
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Change Log

Version	Modifications of document	Author	Date
001	Original version	Ralf Rickert	2021-01-21
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Publishable summary

When Phase Change Materials (PCMs) are used in electric cars, the leakage of any chemicals (e.g. paraffin) need to be excluded. There are two common ways to prevent paraffin from leakage: encapsulation or form stabilization. Our results in micro encapsulation show that it is possible to micro-encapsulate paraffin in different types of shells, but it is difficult to maximize the core shell ratio. A high core/shell ratio leads to better thermal properties and enthalpy but also to low resilience and vice versa. Paraffin in thermoplastics elastomers like SEBS as supporting material provides form-stable gel up to 90 weight (wt.) % paraffin content. A systematical investigation of molecular parameters of SEBS, molecular weight, styrene content and E/B ratio showed that the transition temperatures T_1 and T_2 depends on the molecular weight and styrene content and are mainly determined by the molecular weight of styrene block. T_1 describes the transition from hard gel to soft gel and is shown by a local maximum of G'' in rheological measurements. T_2 describes the transition from gel to solution and exhibit by intersection from G' and G''. This transition temperature is mainly influenced by dissolving the styrene block rather than by the glass transition temperature T_g of polystyrene (PS). T_1 and T_2 are also influenced by the paraffin: transition temperatures increase with increasing number of carbon atoms (C atoms) in the paraffin. By adding thermally conductive materials like aluminum, aluminum oxide or graphite, the thermal conductivity can be increased by simultaneous reducing the enthalpy. The lower the mass of the filler, the lower the enthalpy reduction. The leakage test revealed positive impact of the thermal conductive filler. Promising results in terms of low enthalpy reduction and good leakage behavior were obtained with graphite as thermally conductive filler.

Different concepts to increase the enthalpy and reduce the leakage behavior led to some experiments with silicone. The results show that platinum catalyzed silicones do not cure in the presence of SEBS. When alternative catalysts were used, curing of silicones was possible even in the presence of SEBS. However, silicones as supporting material decreases dramatically the enthalpy. The use of silicone as macro-encapsulation materials was not further investigated because of issues during processing (incomplete macro encapsulation). Macro-encapsulation was rather realized with pre-shaped barrier foils; SEBS/paraffin macro-encapsulated by PET/Al or PE/PA/EVOH/PA/PE multilayer sheets no observable leakage behavior in the isothermic oven testing at 60°C in the experimental time window about 160 h.
Cycle tests with up to 60 heating and cooling cycles (between 20°C and 60°C) of SEBS/paraffin gel show no influence on the thermal properties and the enthalpy is constant. Hybrid supporting material with PE/SEBS show lower thermo-mechanical properties than pure SEBS as supporting material also worse leakage behavior.

For further improvements of thermo-mechanical properties and retention behavior of the supporting material for RT18HC as PCM, chemical cross-linkable materials were investigated as an alternative for SEBS. Finally, EPDM Vistalon 5601P and SEEPS Septon V9461 could be cross-linked chemically. Both supporting materials show thermal stability up to 200 °C without any gel-sol transition. EPDM could not be investigated with our trials and the focus was thus on SEEPS. Further investigations with different ratio of initiator concentration and variation of cross-linking agent show the influence of these parameters on thermo-mechanical properties and leakage behavior. Three of the investigated variants show better thermo-mechanical properties and retention behavior than G1633/RT18HC, implemented in the demonstrator.

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Project partners:

#	Partner	Partner Full Name
1	IDIADA	IDIADA AUTOMOTIVE TECHNOLOGY SA
2	CRF	CENTRO RICERCHE FIAT SCPA
3	TME	TOYOTA MOTOR EUROPE
4	Volvo Cars	VOLVO PERSONVAGNAR AB
5	AGC	AGC GLASS EUROPE SA
6	DNTS	DENSO Thermal Systems S.p.A.
7	Faurecia	Faurecia Sièges d'Automobile
8	HUTCH	HUTCHINSON SA
9	IEE	IEE International Electronics & Engineering S.A.
10	LIST	LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY
11	COV	COVENTRY UNIVERSITY
12	Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
13	IKA	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN
14	TECNALIA	FUNDACION TECNALIA RESEARCH & INNOVATION
15	VIF	Kompetenzzentrum - Das Virtuelle Fahrzeug, Forschungsgesellschaft mbH
16	UNR	UNIRESEARCH BV
17	FIS	Faurecia Interieur Industrie
19	FCA	Fiat Chrysler Automobiles Italy SPA

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7 Appendix A – Quality Assurance

The following questions should be answered by all reviewers (WP Leader, peer reviewer 1, peer reviewer 2 and the technical coordinator) as part of the Quality Assurance Procedure. Questions answered with NO should be motivated. The author will then make an updated version of the Deliverable. When all reviewers have answered all questions with YES, only then the Deliverable can be submitted to the EC.
NOTE: For public documents this Quality Assurance part will be removed before publication.

Question	WP Leader	Peer reviewer 1	Technical Coordinator
	Hélder DE CAMPOS GARCIA	Cédric HUILLET	IDIADA
1. Do you accept this deliverable as it is?	Yes	Yes	Yes
2. Is the deliverable completely ready (or are any changes required)?	Yes	Yes	Yes
3. Does this deliverable correspond to the DoW?	Yes	Yes	Yes
4. Is the Deliverable in line with the DOMUS objectives?	Yes	Yes	Yes
a. WP Objectives?	Yes	Yes	Yes
b. Task Objectives?	Yes	Yes	Yes
5. Is the technical quality sufficient?	Yes	Yes	Yes