MANUFACTURING AND FLAME RETARDANCY MODIFICATION OF MONO-MATRIX SANDWICH COMPONENTS

Please VOTE for me and scan this QR code

Abstract

Sandwich composites offer a broad range of opportunities with regard to lightweight applications and therefore eco-efficiency. Nevertheless, due to the heterogene material mix used in conventional sandwich applications recyclability is often questioned.

In this context thermoplastic mono-matrix sandwich components, where fusion bonding of the face-sheets to the core without any additional adhesive is applicable, may be a promising approach. In this work a new fusion bonding process for PP-GF-UD-tape laminate face sheets with and without flame retardants (FR) and EPP-foam core is presented. In addition, tests comparing the flame retardancy properties of single face-sheets in form of UD-tape laminates (TL) with sandwich (SW) structures are reported.

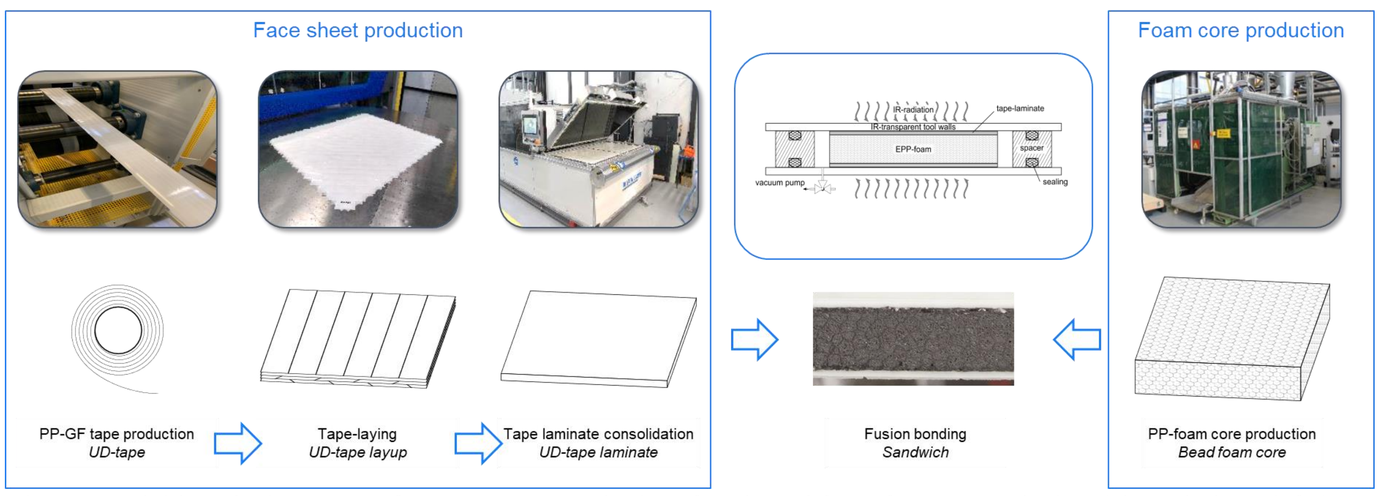

Figure 1: Sandwich production process – from UD-tape to tape-laminate face sheets (left); pp-foam core production (right) and schematic fusion bonding process (middle)

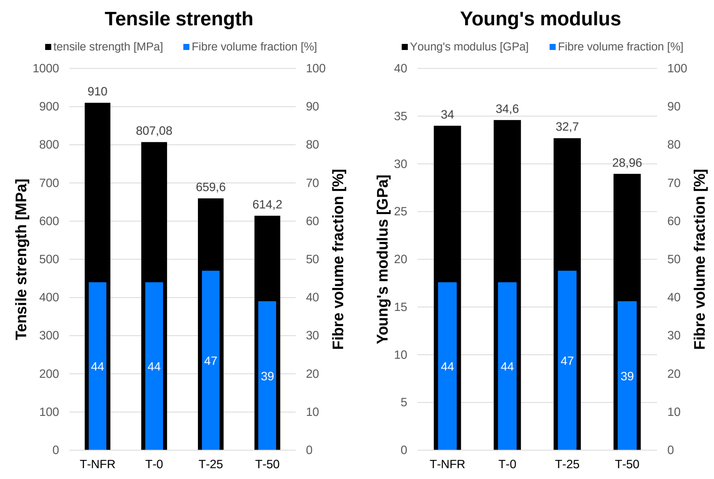

Figure 2: mechanical properties of tape-materials as a function of weight fraction of flame retardant in matrix (T-NFR commercial reference)

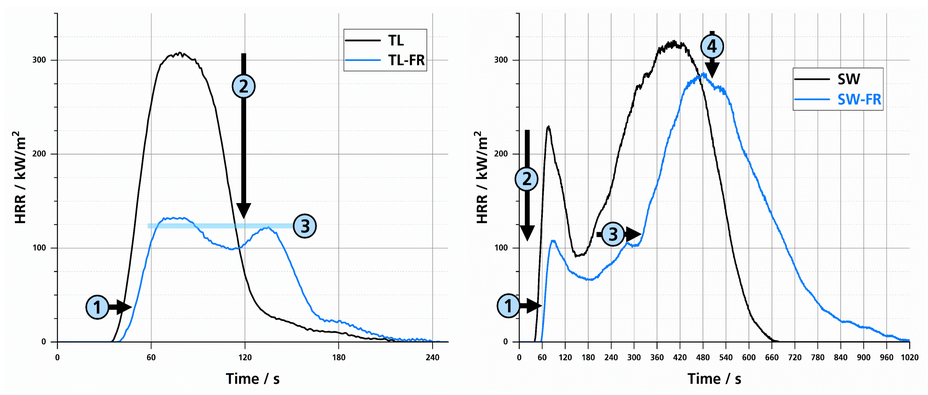

Figure 3: Selected heat release rate (HRR) curves. Left side: Tape laminates TL and TL-FR.
***(1)** time to ignition (TTI) increases by 21 %; **(2)** reduction of the peak heat release rate (pHRR) by 59 %; **(3)** formation of a heat release rate (HRR) plateau at about 120 kW/m²; decrease of the total heat release (THR) by 36 % and an increase of char formation of 8 % is observed for TL-FR.*
*Right side: Sandwich structures SW and SW-FR. **(1)** TTI increases by 32 %; **(2)** reduction of the pHRR of the external surface TL of the SW (first local maximum) by 57 %; **(3)** increase of the TTI of the EPP foam core (second/global HRR peak); **(4)** reduction of the pHRR of 13 %. THR and the char formation slightly decreases for SW-FR.*

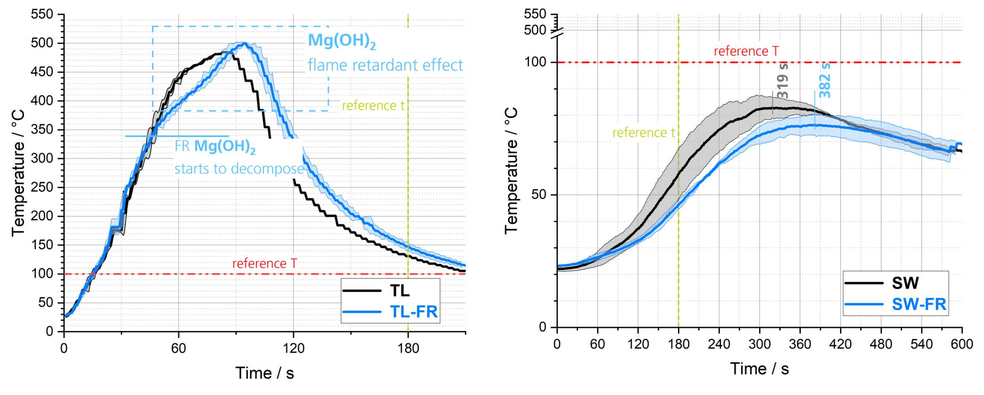

Figure 4 Temperature profile of the specimen back side measured by the bench scale fuel fire test. Left side: Tape laminates TL and TL-FR. Right side: Sandwich structures SW and SW-FR. For a better comparison reference lines for time (t) and temperature (T) are included.

#	TTI / s	Afterflame / s	pHRR / kW/m²	THR / MJ/m²	Residue / %
TL	34 ± 2	272 ± 59	312 ± 5	19.9 ± 0.5	69.0 ± 0.7
TL-FR	41 ± 3	252 ± 6	128 ± 4	12.8 ± 0.2	74.6 ± 2.0
SW	41 ± 7	846 ± 91	291 ± 40	109.3 ± 3.8	47.2 ± 0.8
SW-FR	54 ± 7	1081 ± 80	253 ± 29	107.7 ± 2.4	44.8 ± 0.7

Table 1: Cone calorimetry test results

#	Back side ignited	Mass loss / %	$T_{max,\ back\ side}$ / °C	t of $T_{max,\ back\ side}$ / s
TL	1 of 2 specimen	23.7 ± 2.6	482 ± 2.8	82 ± 3.5
TL-FR	no	18.8 ± 0.1	500 ± 1.3	95 ± 0.7
SW	no	5.9 ± 0.3	83 ± 3.3	332 ± 22
SW-FR	no	4.6 ± 0.1	77 ± 3.8	382 ± 7

Table 2: Bench scale fuel fire test results

Conclusion

The fusion bonding sandwich process for PP shows promising results for the production of lightweight mono-matrix sandwich components. A bending stiffness of 1,945.5 Nm and an areal weight of 5.35 kg/m² for a 12 thick sandwich structure could be achieved. Regarding the tape manufacturing process, further studies of the flame retardant modifications are mandatory to reduce effects on the mechanical performance.

Based on cone calorimetry and bench scale fuel fire test results, both PP-GF-EPP SW structures, containing either FR-free TLs or flame retardant TLs, are promising housing materials for rechargeable energy storage systems (REESS) applications in electric vehicles and are recommended for future fire resistance tests on fully equipped REESS by UNECE-R100-8E tests.

sampe
Live & Virtual Conference 21 Baden/Zürich

Sascha Kilian, Carl-Christoph Höhne, Andreas Menrath | Fraunhofer ICT
Joseph-von-Fraunhofer-Str. 7, 76327 Pfinztal, GERMANY
Benjamin Tillner | Fraunhofer IMWS
E-mail: sascha.kilian@ict.fraunhofer.de

Fraunhofer ICT
Fraunhofer Institute for Chemical Technology ICT