Evaluation of the ultrasonic sealing performance of flexible monolayer polyolefin films and paper/polyolefin laminates

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Introduction

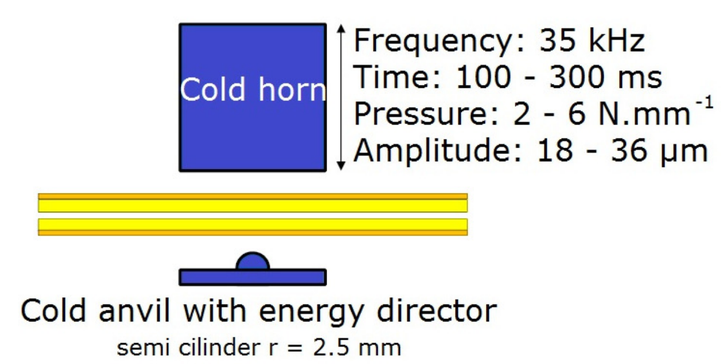
The objective of this study was to evaluate the ultrasonic sealing performance against the heat conductive seal strength of both common polyethylene (PE) and polypropylene (PP) sealing materials and paper/polyolefin laminates. Paper/polyolefin laminates are light, flexible materials with good printability and with an authentic feel. However, studies on the ultrasonic sealing performance of these materials are very limited.

Materials and methods

Table 1: Composition, measured total thickness and production process of films

Composition	Measured total thickness (µm) (n=10)	Production process
Monolayers		
LDPE 60	63 ± 2	Blown extrusion
mLLDPE-C6 60	64 ± 2	
LLDPE-C6 60	58 ± 3	
LLDPE-C4 60	63 ± 2	
homopolymer PP (=homo PP) 60	61 ± 3	Cast extrusion
random copolymer PP (=raco PP) 60	58 ± 3	
Paper Laminates		
Paper uncoated+uncalendered/mLLDPE-C6 50/60	110 ± 4	Blown extrusion, corona pretreatment and lamination
Paper uncoated+uncalendered/mLLDPE-C6 50/60	118 ± 2	
Paper uncoated+uncalendered/mLLDPE-C6 50/60	104 ± 2	
Paper uncoated+uncalendered/mLLDPE-C6 50/60	111 ± 2	
Paper uncoated+uncalendered/raco PP 50/60	105 ± 9	Cast extrusion, corona pretreatment and lamination
Paper coated+uncalendered/raco PP 50/60	114 ± 5	
Paper uncoated+calendered/raco PP 50/60	100 ± 3	
Paper coated+calendered/raco PP 50/60	108 ± 7	

Figure 1: Ultrasonic seal settings



- Evaluation of ultrasonic seal performance
  - Seal strength: compared with maximum heat conductive strength (figure 2)
  - Energy consumption (figure 3)
  - Seal compaction (figure 4)
  - Seal window (table 2)

Results and conclusions

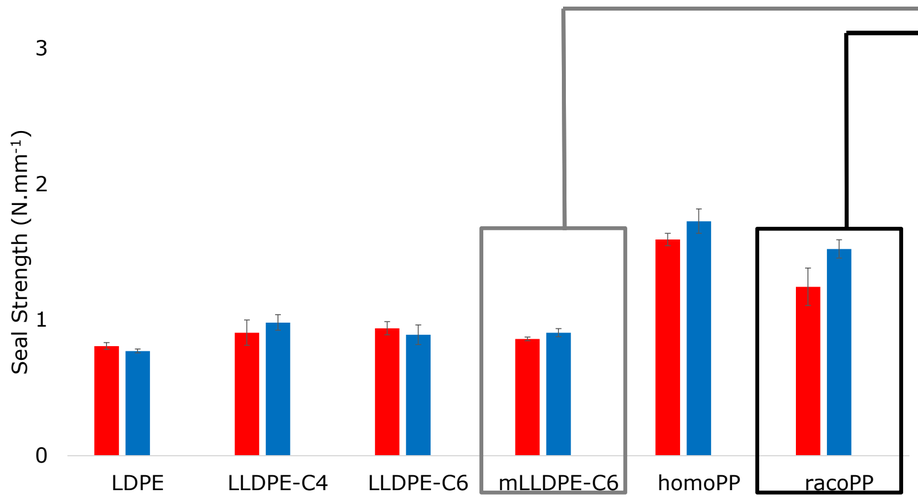
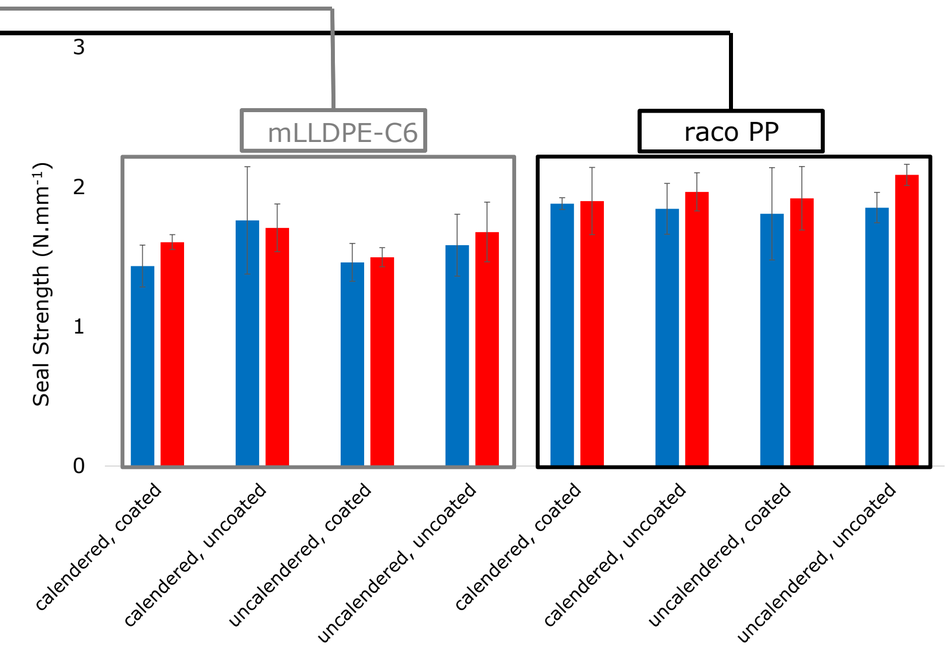


Figure 2: Comparison maximum seal strength

- Maximum seal strength monolayers: PE < PP
- Selection ultrasonic best performing monolayers
  PE: mLLDPE-C6: good maximum seal strength (figure 2), wide ultrasonic seal window (table 2) and a low energy consumption (figure 3)
  PP: raco PP: good maximum seal strength (figure 2), wide ultrasonic seal window (table 2)



- Laminated paper samples combine high strength of paper layer with sealing properties of polyolefin layer
- No influence of paper production on maximum ultrasonic and heat conductive seal strength

Figure 3: Comparison ultrasonic energy consumption

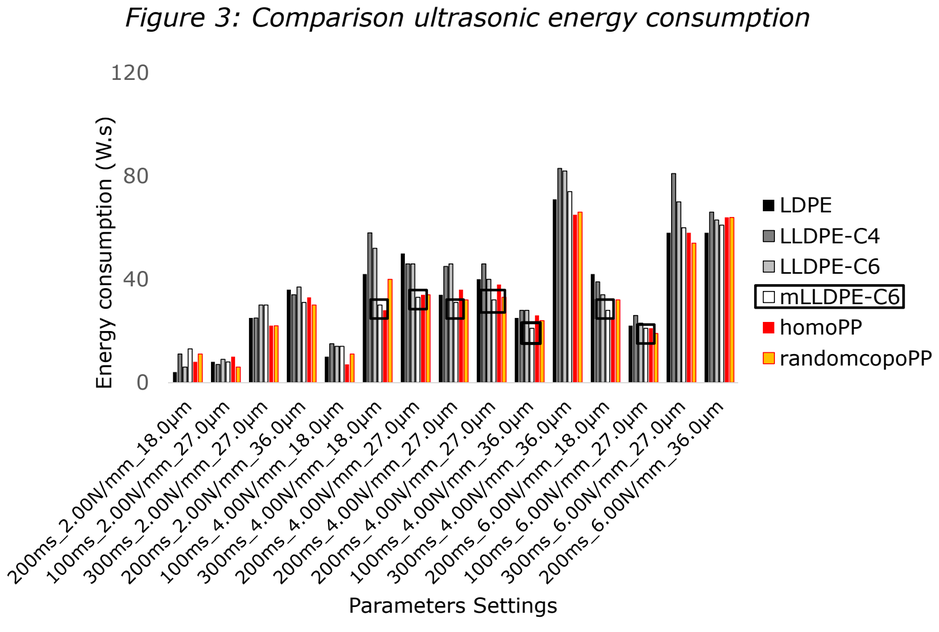
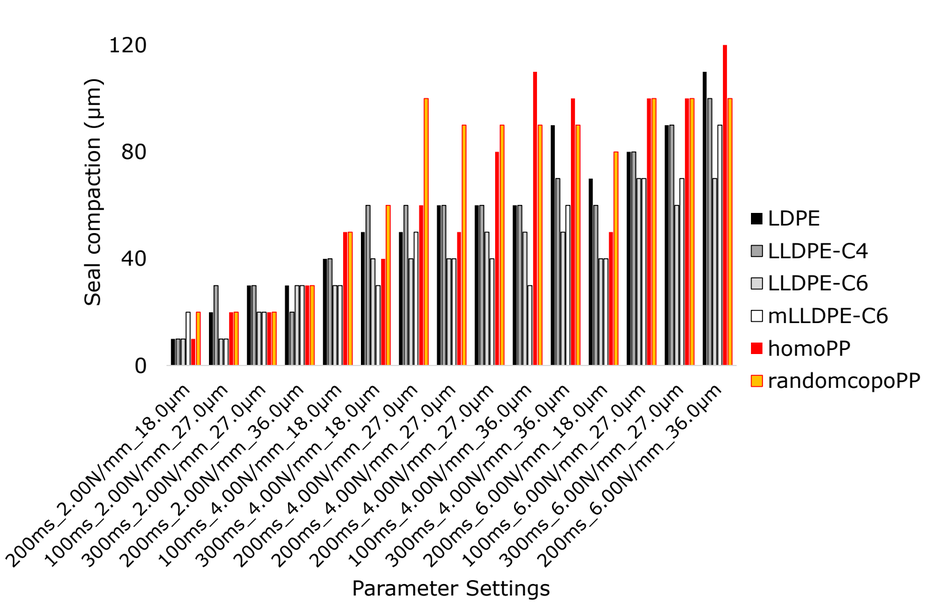


Table 2: Comparison ultrasonic seal window monolayers: amount of tested settings with a seal strength > 0.05N.mm^{-1}

	USS_{window}
LDPE	11/15
LLDPE-C4	9/15
LLDPE-C6	11/15
mLLDPE-C6	11/15
HomoPP	9/15
RacoPP	13/15

Figure 4: Comparison ultrasonic seal compaction



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