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Next Generation Diapers: Increasing Elastic Laminate Toughness

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MULTIDISCIPLINARY

Next Generation Diapers

Increasing Elastic Laminate Toughness

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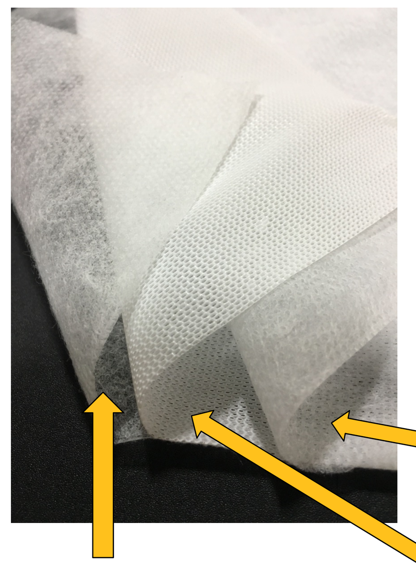
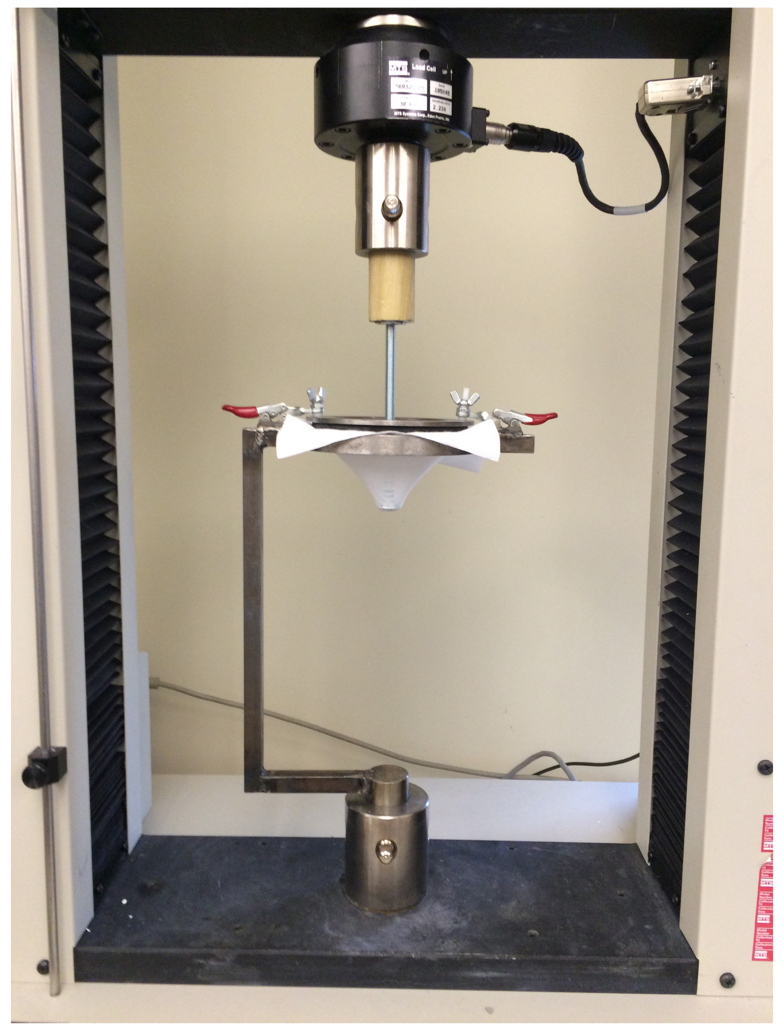
Background

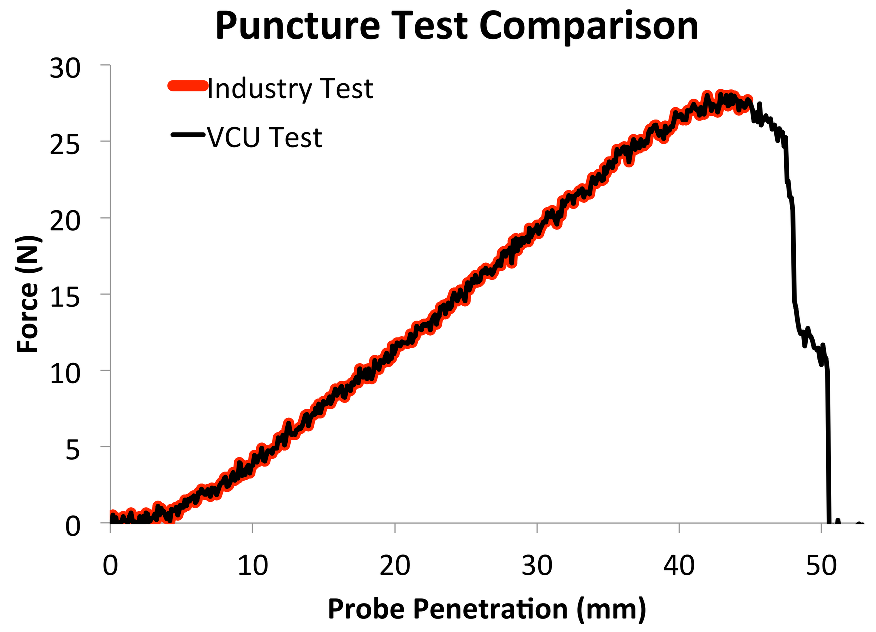
Disposable diapers are prone to accidental damage during typical use. In particular the caregiver may rip or puncture the elastic material. In order to reduce the incidences of material failure, the toughness of the elastic trilaminate body paneling material needs to be improved, while its desirable properties like elasticity need to be retained. This would increase the value of this product in the eyes of parents and adults suffering from incontinence.



Puncture Resistance



Standard puncture resistance tests are deficient, therefore a new testing apparatus was developed. The improved test more completely characterizes a laminate's puncture behavior.

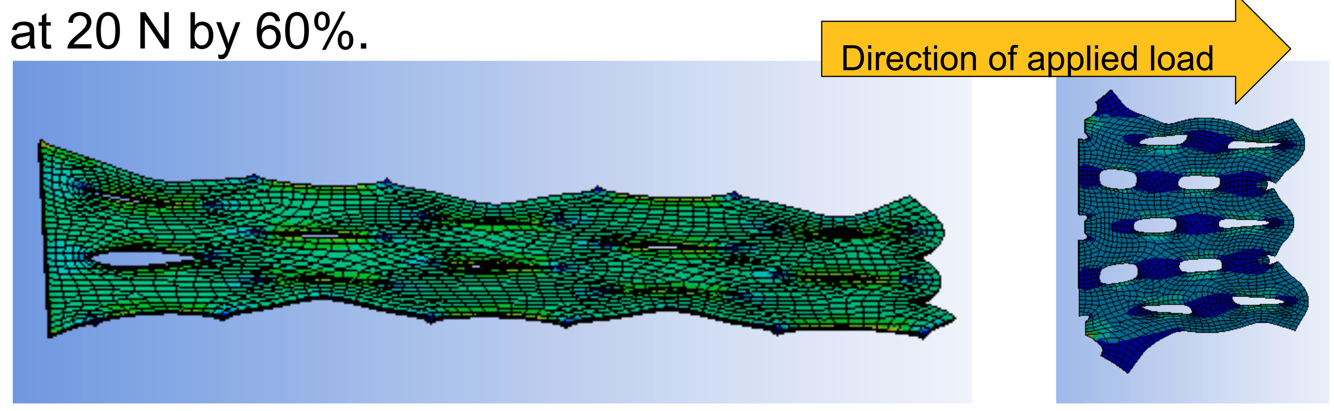


Approach

It was determined that the focus was on improving the puncture resistance and tensile properties of the elastic film component of the trilaminate to quantify toughness. Both computational modeling and systematic experiments were used to tackle this problem.

Finite Element Analysis

ANSYS failure modes and effects analysis was used to determine the effect of changing the density and orientation of the apertured holes on toughness. A model supplemented by empirical data demonstrated that rotating the holes and decreasing hole density increased the maximum stress at 20 N by 60%.



Design of Experiments

DOE's were run to evaluate the following independent variables: extruder die temperature, resin blend, cross directional stretch activation depth, and line speed. A full factorial design was utilized to quantify the impact of single variables and interactions.

Decreasing the activation depth increased toughness by the largest margin, decreasing the die temperature improved the toughness somewhat and significantly increased the effect of altering the activation depth. Altering the line speed was found to have no effect.

Altering the resin blend from blend A to blend B lead to a tougher laminate as well; however, the other desirable properties, such as the elasticity and ease of stretch degraded.

Results

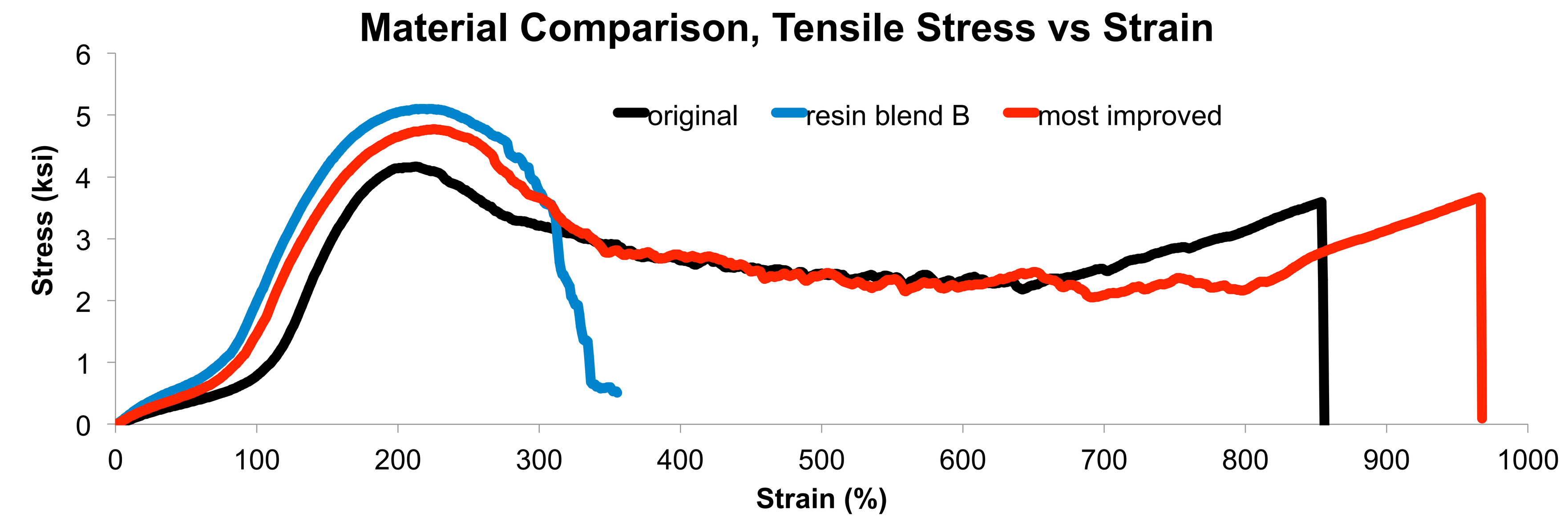
sample	die temp	actv. depth	resin blend	average peak load (gf)	% change	average punct. resist. (N)	% change	average % elong. @ break	% change
original	std	std	A	5353	-	31.7	-	850.2	-
low temp	low	std	A	5965	11.4%	29.8	-6.1%	827.5	-2.7%
best toughness	low	low	A	6408	19.7%	37.3	17.5%	898.7	5.7%
most improved	std	low	A	6212	16.1%	35.3	11.5%	974.3	14.6%
resin B	-	std	B	6550	22.4%	40.6	28.2%	420.8	-50.5%

Conclusions

A set of process conditions that improved tensile and puncture properties was found.

Improved Properties
- 11.5 % inc. in puncture force
- 16.1 % inc. in peak load
- 14.6 % inc. in % elong. @ break

Retained Properties
- Air permeability (breathability)
- Total Cost
- Good ease of stretch



Further improvements in toughness can be achieved by producing material with the altered apertured hole configurations at the processing conditions found to be most favorable.