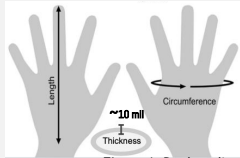


# Reusable TPV Medical Grade Gloves

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## Introduction

- The main goal of this project is to design a medical grade glove that can be sterilized via autoclave and used multiple times.
- Single use disposable gloves attribute to 30 billion pounds of plastic waste in landfills.
- Medical and laboratory practices could benefit from use of reusable gloves as it would decrease the environmental footprint caused by glove use.
- Made of Santoprene TPV
  - Good physical properties and chemical/heat resistance
  - Polyolefin based & completely recyclable



Size	L (cm)	Circ. (cm)
XS	< 16.5	< 19
S	16.5-17.5	19-20
M	17.9-19.1	20-21
L	19-20.3	21-22.5
XL	20.3-21.6	22.5-24

Figure 1: Product dimensions and sizing guide

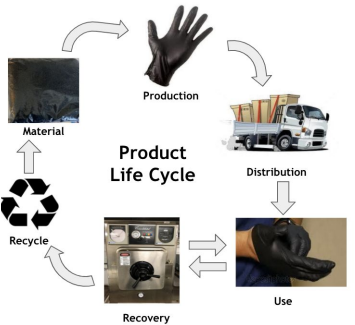


Figure 3: TPV Glove Life Cycle

Table 1: Simplified Net Product Value

Model Parameter	Base-Case Value	4 Year Plan (\$M)				
		Y1	Y2	Y3	Y4	
Product development	\$1M over 1 year	Sales, machines				
Equipment & Tooling	\$900K over 1/2 year	Sales volume (units/qrtr)	0	250000	287500	330625
Product ramp-up	\$500K over 1/2 year	Wholesale revenue (\$/unit)	0	60.0	57.0	54.2
Market and Support	\$600K over 1/2 year	Total revenue millions	0	37.5	41.0	44.8
Production cost	\$5/unit	Product development	1	0	0	0
Production Overhead	\$200,000	Equipment and tooling	0.9	0	0	0
Initial Production Volume	250,000 units/year	Product ramp-up	0.25	0.25	0	0
Quarterly Sales profile	Q1 20%, Q2 25%, Q3 25%, Q4 30%	Marketing and Support	0.3	0.75	0.6	0.6
Sales Volume Growth	15%/year, after first year	Production cost	0	12.5	14.38	16.53
Initial Retail Sales Price	\$15/unit (1 unit has 24 gloves)	Total Cost	2.45	13.5	14.976	17.131
Retail price growth	5%/year, after first year	Period Cash Flow	-2.45	24.0	26.0	27.6
Distributor and Retail Margin	40%	Period Present Value	-2.33	22.80	24.69	26.25
Discount Rate	5%/year	Net Present Value	71.41			

## Prototyping Methods

- Prototype 0:** Creation of the glove film by using a heated press
  - Mass = 2.5g
  - T = 200°C
  - P = 2000 psi
  - Time = 15 minutes
- Prototype 1:** Heat degradation in autoclave
  - T = 120°C
  - Cycle Time = 15 minutes
  - Cycle Type: Dry
  - Samples: 0x, 1x, 5x, 10x

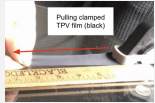
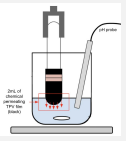


Figure 2: All prototype setups

## Results:



Figure 5: Different autoclave cycle films (Prototype 1)



Figure 4: Film creation (Prototype 0)

Table 2: Permeation test (Prototype 2) using 2 different chemicals on materials with increased autoclave cycles. Note: Permeation rate cannot exceed 0.1 mg/s·m² per FDA guidelines.

Autoclave cycles	Chemical	Permeation Rate (mg/s·m²)
Not Autoclaved	H <sub>2</sub> O <sub>2</sub>	0.0158
	HCl	0.0067
Autoclaved 1X	H <sub>2</sub> O <sub>2</sub>	0.0574
	HCl	0.0065
Autoclaved 5X	H <sub>2</sub> O <sub>2</sub>	0.0271
	HCl	0.0063
Autoclaved 10X	H <sub>2</sub> O <sub>2</sub>	0.005
	HCl	0.395

\*DMSO was omitted because pH range (6-8) is unstable and overlaps with DI water

Table 3: Elasticity % (Prototype 3) with increasing autoclave cycles. Note: Elongation must exceed 400% per FDA guidelines.

	Elongation % At Break
Not Autoclaved	100%
	88%
	116%
Autoclaved 1X	116%
	76%
	87%
Autoclaved 5X	100%
	70%
	100%
Autoclaved 10X	85%
	82%
	83%
Nitrile Lab Gloves (Large)	193%
	176%
	118%

## Conclusions

- No films pass FDA requirements for elongation
- All autoclave cycles pass permeation test against H<sub>2</sub>O
- All autoclave cycles pass permeation test except 10X against HCL
- Further testing and refinement of material is required to know if it would be adequate for use as a reusable medical glove

## Next Steps

- Decrease overall thickness
- Increase uniformity
- Mix TPV with rubber to increase elasticity
- Increase number of autoclave cycles
- Use universal testing machine
- Different permeation testing method
- Use newer lab gloves for comparison

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