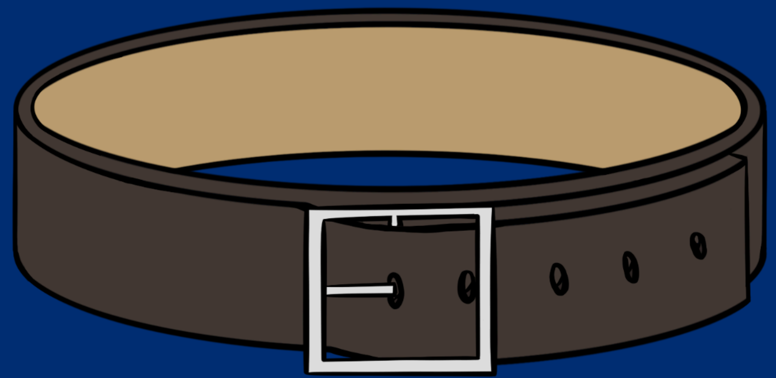

DiscreetHeat

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Motivation & Impact

Lower back and abdominal pain are common conditions that can interfere with daily life:

- **80%** of people who menstruate have experienced **abdominal cramps**.[1,2]
- **190 million** people around the world have **endometriosis**.[3]
- **23%** of adults worldwide suffer from **chronic low back pain**.[4]
- **95%** of males and **70%** of females older than 60 have **spinal arthritis**.[5]

Studies have shown that **heat therapy can reduce menstrual and low back pain more effectively** than oral medications, but[6,7]

- Traditional heating pads are bulky and require a power outlet.[8]
- Wearable heating pads resemble medical devices, making users uncomfortable in public.
- Adhesive heat wraps can cause skin irritation or burns.[9,10]

Our product is a **discreet wearable heating pad designed to look and function like a standard belt** for convenient use in public.

Product Specifications

What makes our product effective?

- Powered by a small 7400 mAh lithium polymer battery and charged through the USB-C port in the charging board within the electronics pocket.
- Mobile app allows users to select the heat level and monitor charging.
- Graphene maintains a uniform temperature distribution even when bent, and it quickly spreads heat due to its high in-plane thermal conductivity.

Layer	Material	Thickness	Thermal Conductivity
1	Cowhide leather	1.0 mm	0.140 W/mK[11]
2	Porous polyimide film	0.1 mm	0.012 W/mK[12]
3	Silicone rubber	1.4 mm	0.200 W/mK[13]
4	Silicone rubber	6.0 mm	0.200 W/mK[13]
	Polyurethane film	2.0 mm	0.060 W/mK[14]
	Lithium/polymer	4.0 mm	0.600 W/mK[15]
5	Silicone rubber	0.7 mm	0.200 W/mK[13]
6	Porous polyimide film	0.1 mm	0.012 W/mK[12]
	Graphene	0.1 mm	19.00 W/mK[16]
7	Polyimide film	0.05 mm	0.800 W/mK[17]
8	Polyester	0.5 mm	0.050 W/mK[18]

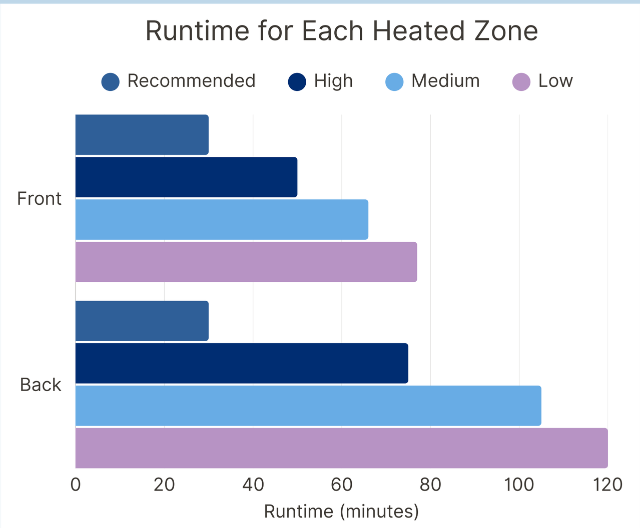

Figure 1. Calculated runtime for each heated zone compared to the recommended safe duration of treatment.[19]

Market Need

Disposable chemical heating systems
- Not reusable

Rechargeable electrical heating devices
- Not discreet

Over-the-counter pain medication
- Indirect competitor

Patent landscape
- Opportunity to file patents in underdeveloped areas
- Licensing existing intellectual property


Figure 2. Model wearing ThermaCare Menstrual Pain Therapy heat wrap.[20]


Figure 3. Model wearing Comfytemp electric heating device.[21]

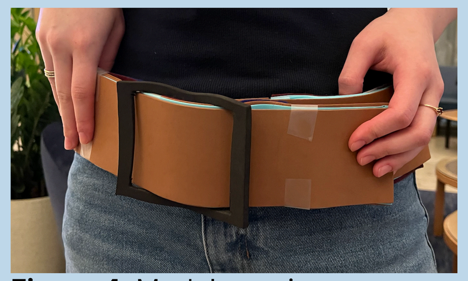
Figure 4. Model wearing DiscreetHeat prototype.

Manufacturing Process

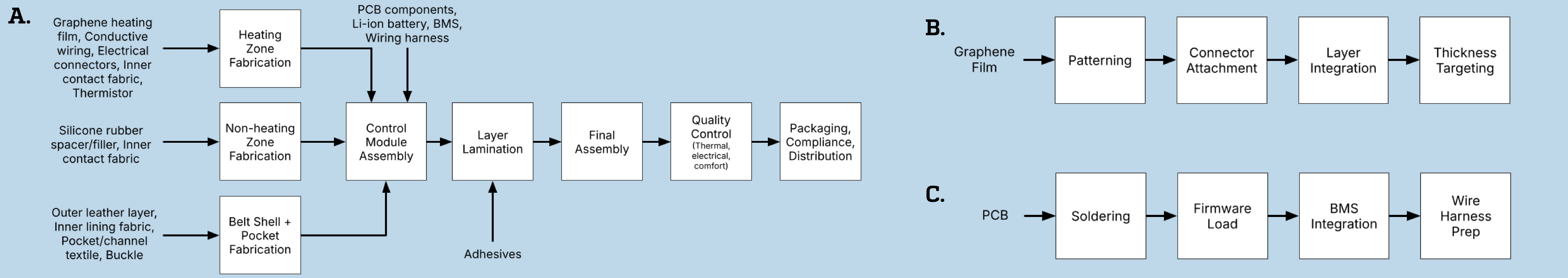

Figure 5. Overview of the DiscreetHeat belt manufacturing process. **A.** Full production workflow, including parallel fabrication of the heating zone, non-heating zone, and belt shell, followed by control module integration, lamination, final assembly, quality testing, and distribution. **B.** Heating zone fabrication process, including graphene film patterning, electrical connector attachment, and integration with supporting layers to achieve the target thickness. **C.** Control module assembly, including PCB soldering, firmware loading, battery management system (BMS) integration, and wire harness prep.

Final Product Design

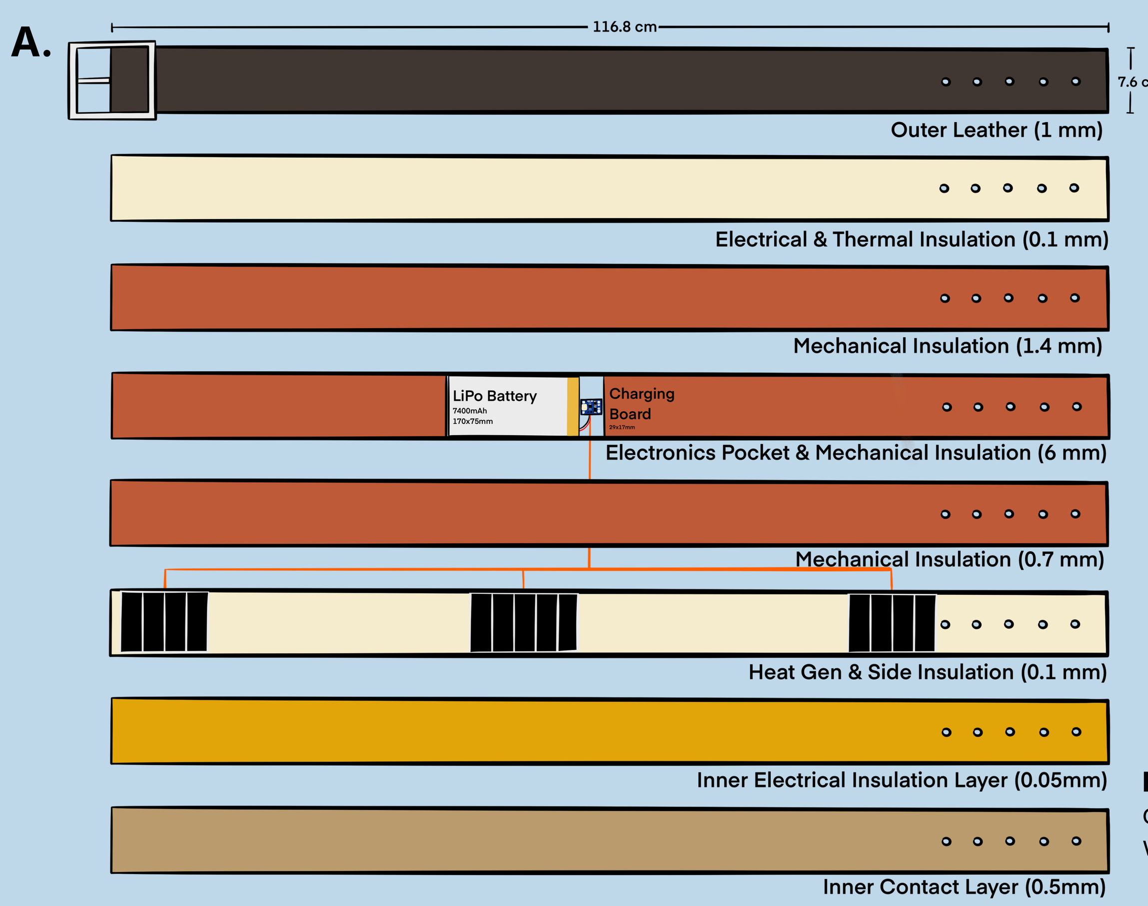

Figure 6. Finalized product design. **A.** Flat view of all layers. **B.** Visual of DiscreetHeat layers when buckled.

Financial Analysis

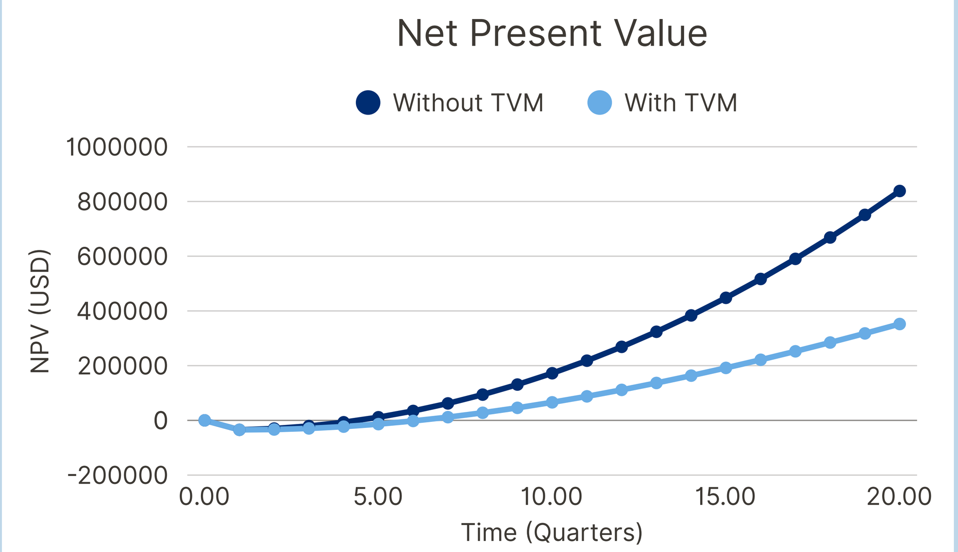

Figure 8. Net Present Value (NPV) graph. Internal Rate of Return is roughly 40%. Final NPV ~ $350k.

- **Price:** $60
- **Units:** 200 per quarter
- **Cost per unit:** $20.47
- **Tax:** 35%
- **Discount rate:** 10%
- **Final NPV:** ~$27K

Break-even (no TVM): ~Q10 (2.5 years)
Break-even (with TVM): ~Q11 (2.75 years)

Heat Transfer Modeling

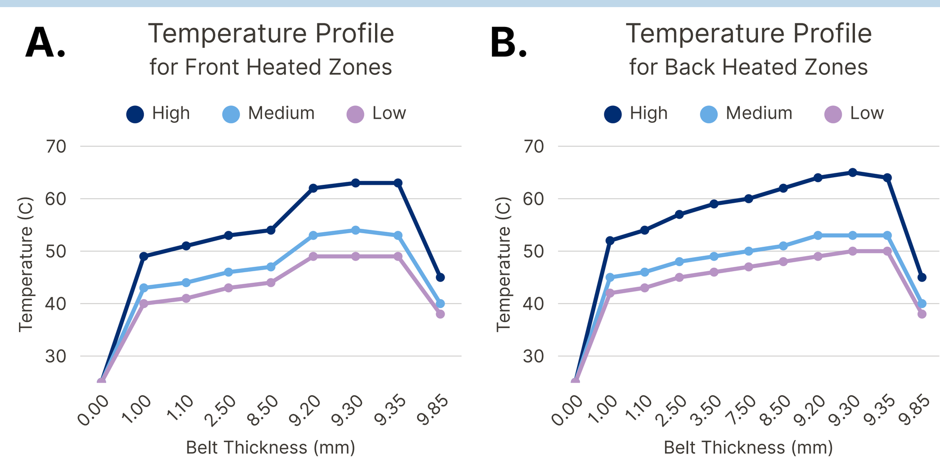

Figure 7. Calculated temperature profile for all settings: 45°C (high), 40°C (medium), and 38°C (low). **A.** Front heated zone temperature profile. **B.** Back heated zone temperature profile.

Assumptions

- In-plane (xy-plane) heat transfer can be neglected
- Fourier's Law of 1D Heat Conduction applies
- All usable energy is converted to heat

Key Equations

Fourier's Law:[22,23] $q_z = -kA\frac{dT}{dz}$

Thermal resistance:[22,23] $R = \frac{L}{kA}$

Power:[24] $P = I \times V$

Final equation:[25]

$$T_{graphene} = \frac{P_i + \frac{T_{body}}{R_{body}} + \frac{T_{air}}{R_{air}}}{\frac{1}{R_{body}} + \frac{1}{R_{air}}}$$

Symbols

q	Heat	P	Power
A	Area	I	Current
k	Thermal conductivity	V	Battery voltage
T_{body}	Temperature delivered to body (target temperature)		
T_{air}	Temperature of the air; room temperature		
$T_{graphene}$	Temperature of graphene to reach target temperature		

Regulations

Consumer Safety
- Consumer Product Safety Commission (CPSC) compliance

Battery and Shipping
- UN 38.3 (Li-ion battery) compliance
- Labeling requirements

Electrical Safety
- UL (electrical wearables) compliance

Additional Questions?

To learn more, check out our references or contact information using the QR codes below:

References

Contact Info