Green Tech Bandages

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Abstract—With over 200 million bandages sold every year in the United States, there is a strong need for a sustainable solution. Our team has developed a new, patent pending technology to revolutionize the bandage industry. By using repurposed agricultural waste, our team was able to recreate mechanical properties as seen in current bandages on the market, while also reducing pre-production waste. Our solution also includes an absorbent pad made from plant protein, with absorbent properties comparable to traditional gauze, and a non-irritating adhesive. Our final prototype is mechanically similar to current bandages yet offers the consumer desired features of being sustainably sourced and 100% biodegradable to reduce waste and protect minor wounds that do not require medical attention.

I. INTRODUCTION

Over 200 million units of bandage products are sold every year in the United States alone. Due to this, we can allude to an astronomical number of bandages being discarded every year in the United States, leading to significant increases in landfill waste. Adding to this increasing amount of waste, market predictions from 2020, before the start of the COVID-19 pandemic and mass vaccination campaigns, show a projected increase in bandage sales over the next few years [1]. With accumulating waste via bandages, and a predicted increase in bandage sales, there is an apparent need for an environmentally friendly solution.

Our team has come up with a design that not only reduces waste through degradation but repurposes agricultural waste as well. Green Tech Bandages are a sustainably sourced, biodegradable bandage that reduce waste while protecting minor cuts and wounds that do not require medical attention. Our bandages are created from natural materials combined with electrospun biomaterials in order to create a bandage that is 100% biodegradable.

II. DESIGN PROCESS

Through analyzing survey results from over 220 people and conducting 31 in-depth potential customer interviews, the specific objectives for our design were determined as (1) reduction of waste, (2) ease of use, and (3) affordable price. Beyond this, we identified three main physical components of the bandage, which include the protective scaffold, exudate absorbance layer, and strong adhesive. The design of these three physical properties were iterated by considering the whole bandage design in which these properties work together with each other, as well as separately, to ensure that their individual properties are comparable to market standards. In order to do so, variations of both materials and applications were analyzed in order to create the final prototype design.

III. FINAL DESIGN AND RESULTS

A. Protective Scaffold

The protective scaffold is composed of decellularized corn husks, a common agricultural waste product. The decellularizing process uses detergents, bleaches, and soaps to leave behind only the cellulose scaffold. Preliminary testing demonstrated the husks to be a stiffer and less elastic scaffold compared to current markets standards. Therefore, we employed steam rehydration to return the flexibility needed in this material. Mechanical testing was performed on an Instron-5544 to quantify these properties (Figure 1).

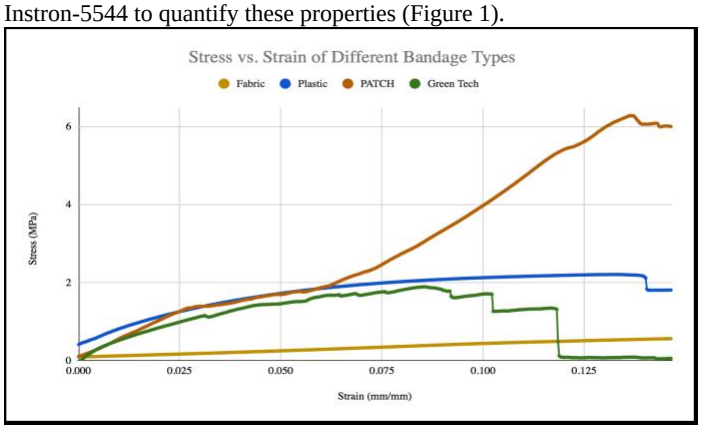

Figure 1: Mechanical Strength of Different Bandage Types

The data showed that our scaffold is comparable to market competitors (Fabric Band-Aid® , Plastic Band-Aid® and PATCH™ Bamboo Bandages).

B. Exudate Absorbent Layer

We developed an electrospun pad from a plant protein called zein, which underwent absorbance testing compared to traditional cotton gauze. The zein protein from corn kernels was mixed with a polymer solution and then electrospun into a soft and absorbent pad. Our gauze replacement statistically absorbed less liquid shown in wet weight testing, with the zein absorbing 201mg compared to 302mg from the gauze, however this can be overcome by increasing the volume of zein used in the bandage application. Additionally, it is rare that bandages are overcome with exudate from minor wounds, so we do not anticipate this causing any issues.

C. Strong Adhesive

It is important that our adhesive adheres both the gauze replacement to the scaffold, and the bandage to the skin. This adhesive must stick well to the skin, but also allow for easy and painless removal. Adhesive testing was completed using a peel-off test protocol with the Instron-5544. To complete this test, our bandage was adhered and pulled from a nonstick Teflon sheet. After each bandage was pulled off of their respective sheets, the load required to complete this action was captured and analyzed.

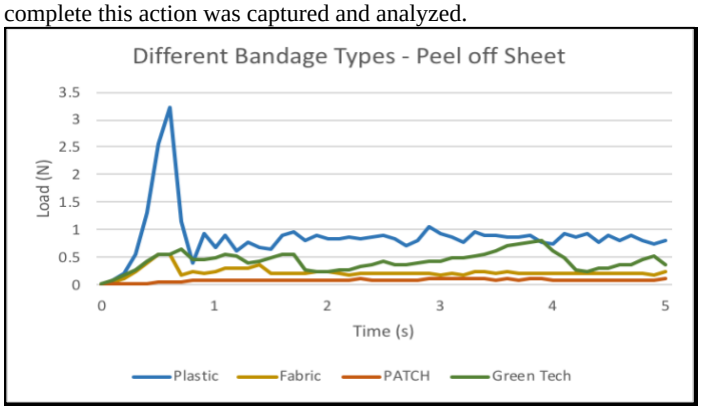

Figure 2: Adhesive Strength off of Peel Off Sheet

As seen in Figure 2, our chosen adhesive has comparable peel off properties to current market competitors (Fabric Band-Aid ®, Plastic Band-Aid ®, and PATCH ™ Bamboo Bandages). We also tested the bandages' adherence on surrogate skin to investigate how our bandage may function on human skin. To represent this, a tensile test was conducted by pulling each bandage type off of surrogate chicken skin. Figure 3 shows how our bandage acts similarly to marketed bandages (Fabric Band-Aid ®, Plastic Band-Aid ®, and PATCH ™ Bamboo Bandages) on the surrogate skin. However, caution should be used interpreting these results as chicken skin does not fully represent how these bandages will adhere to human skin.

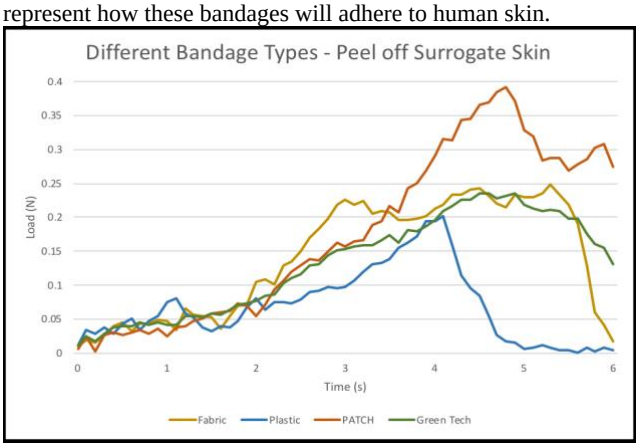

Figure 3: Adhesive Strength off of Surrogate Skin

D. Final Prototype

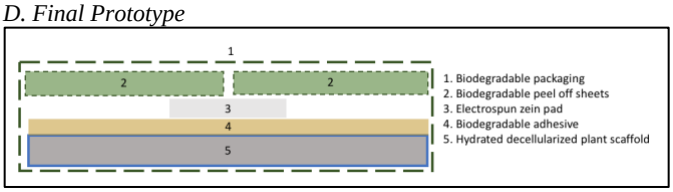

Figure 4: Side View of Bandage Design

Figure 5: Green Tech Bandage Prototype

Our technology, shown in Figures 4 and 5, consists of a decellularized corn husk that is rehydrated to maintain flexibility and add longevity. Next, the absorbent zein pad, a corn-based solution, is used as a gauze replacement. Additionally, our final product includes a water-based, non-allergenic adhesive. Our team applied for a provisional patent for decellularized plant-based bandages.

IV. Discussion

A. Results Overview and Impact

Our technology reduces waste in two specific ways. First, our bandages reduce waste pre-production by repurposing agricultural by-products through the use of corn husks for our main design component. Next, our technology reduces waste post-production by creating a biodegradable product that can reduce landfill accumulation of bandages. Green Tech Bandages are a sustainably sourced and eco-friendly solution.

B. Future Directions

Future recommendations for this project include regulatory testing, wear testing, and finalizing our prototype. We will also create biodegradable packaging with the continued use of agricultural waste. Our model will then be scaled up to marketable production, followed by selling our design to sustainability focused companies. Overall, our product reduces waste that traditional bandages create, as well as waste from the agriculture industry. The Green Tech Bandage is sustainably sourced and 100% biodegradable to reduce waste and protect minor wounds that do not require medical attention.

V. Acknowledgments

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VI. References

[1]"Medical Tapes And Bandages Market Size, Share & Trends Analysis Report By Product (Medical Tapes, Medical Bandages), By Application (Surgical Wound, Ulcer), By End-use, By Region, And Segment Forecasts, 2021 - 2028." Grand View Research. Feb. 2021. [Online]. Available: https://www.grandviewresearch.com/industry-analysis/medical-tapes-bandages-market

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