Ohio Agricultural Research and Development Center

Using Circumallergenic Guayule Natural Rubber Latex to Develop Thin Film Barriers

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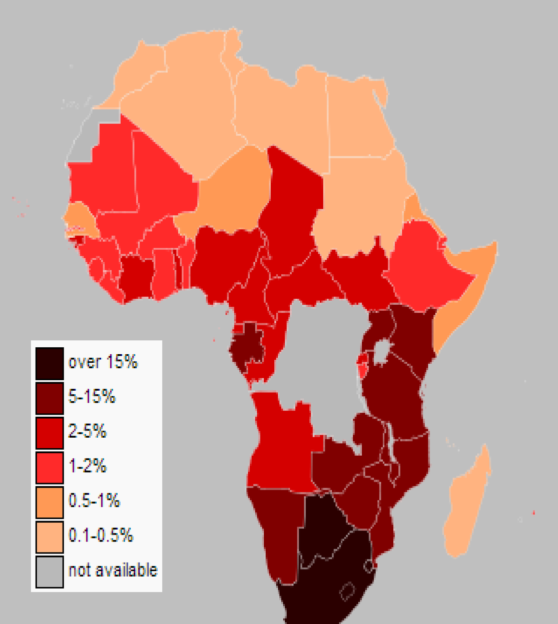
Introduction

In Southern Africa, more than 15% of the population has been infected with HIV/AIDS (World Bank HIV/AIDS in Africa 2011). Condoms can be used to help prevent infection and slow the spread of the disease. *Hevea brasiliensis*, commonly known as the pará rubber tree, produces high quality rubber that is often used to make condoms. However, the proteins in this material can be highly allergenic, causing type I allergic reactions (Cornish, 2012). In addition, accelerators used in cheaper latex recipes can also cause type IV allergic reactions. As a result, many individuals in HIV/AIDS ridden communities do not use condoms if an allergy develops, thereby continuing the spread of the disease. *Parthenium argentatum*, commonly known as guayule, is a desert shrub that also produces high quality natural rubber latex. This plant represents a possible alternative to *Hevea* natural rubber. The advantage of using guayule instead of the pará rubber tree is that guayule is not known to cause allergic reactions (Slutzky, Cornish, 2012), and also grows easily in South Africa. Growing guayule for condoms in South Africa allows the problem to be fixed internally and consequentially fixed sustainably. In addition, new accelerators are being used that have so far shown to be circumallergenic (Slutzky, Cornish, 2012). If guayule condoms could be developed and distributed in HIV/AIDS ridden communities, then that would be a step towards eradicating the disease.

South African guayule shown above. This plant grows well in Africa, coincidently where HIV/AIDS is most pronounced.



The World Bank- Prevalence of HIV, total % of population ages 15-49, in 2011

Methods and Materials

We are working to develop thin film barriers, such as condoms, on a Diplomat Automated Dipper (DipTech Systems Inc., Kent, OH).

Independent variables were:

- Dwell time
- Coagulant concentration
- Number of dips
- Former temperature

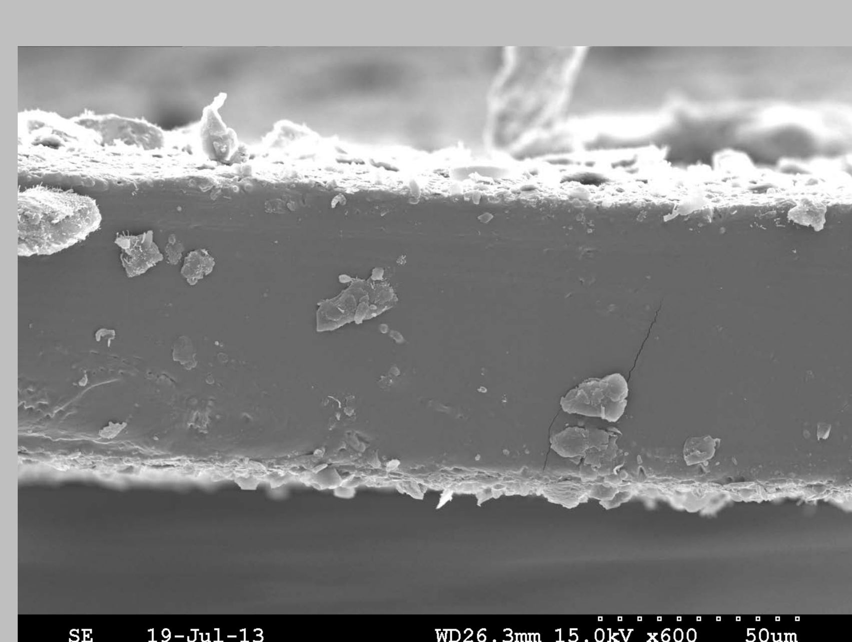
The goal of this experiment was to determine an ideal protocol for thin film barrier production and to gather data pertaining to guayule thin film strength when different steps in the protocol are altered.

An example protocol is below:

1. Heat former at 75 degrees for 15 minutes
2. Attach former to dipper and run program into a batch of well-stirred latex with no bubbles for 60 seconds
3. Cure the resultant coat for 15 minutes in big oven at 100 degrees
4. Dip former in latex again with another 60 second dwell time
5. Cure former in big oven again for 25 minutes
6. Remove former, cuff it, submerge in water (in order to leach proteins), and then cure for another 25 minutes
7. Remove film from former and tumble dry for 60 minutes

The thickness of the films were measured via a Scanning Electron Microscope (SEM). In addition, three barbell shaped samples from each film were cut using an ASTM size D die and tested on a tensionmeter. The mechanical properties tested for were tensile strength, percent elongation at break, and modulus at 500 percent elongation.

Above are examples of condoms created with varying numbers of dips.



Above shows an SEM image of a thin film.

Results

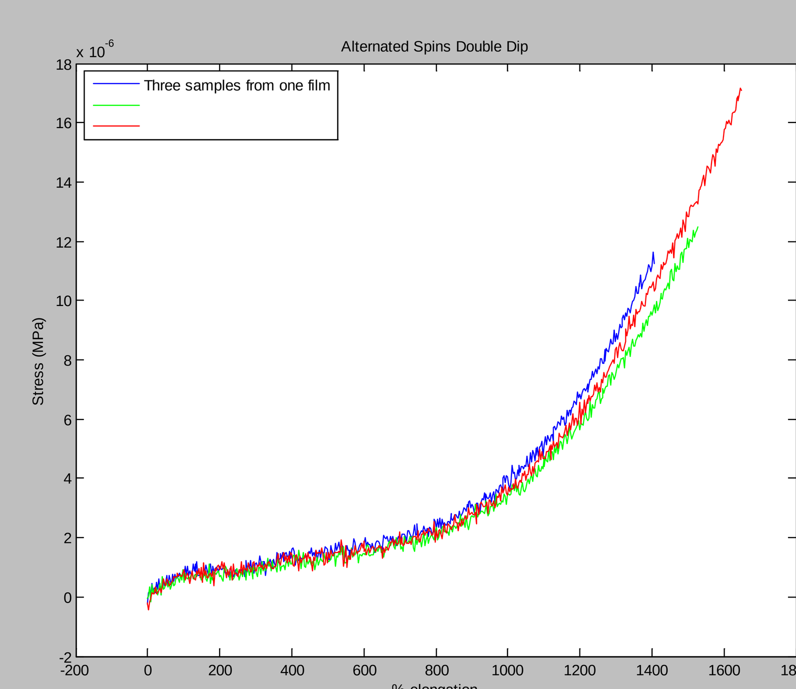
Looking at the data, it can been seen that that number of dips has a direct result on the strength of the film. Each dip increases the thickness of the film so it can be concluded that thinner films are not as strong.

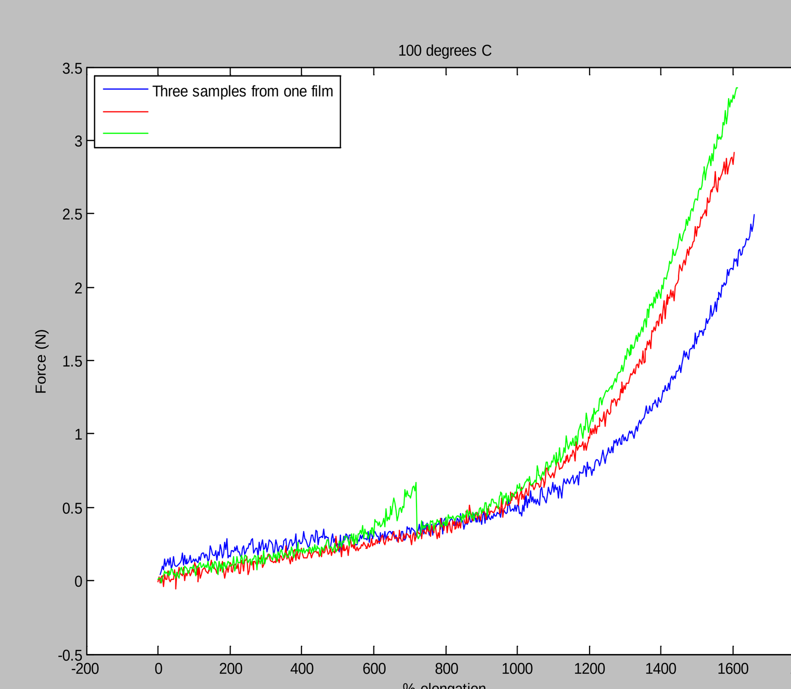
Dwell time is the amount of time that the former sits in the batch of latex before being removed. Dwell times were altered between 15 and 60 seconds, and no difference in film thickness was noted.

Former temperature is predicted to effect film thickness. The hotter the former, the more latex that will cure on the surface of the former.

Cure times have no effect on film thickness. After the first dip, the film was either cured for 15 or 25 minutes between dips and neither resulted in a thicker film.

	Max Load (N)	% elongation at break	Modulus at 500% elongation	Thickness (um)	Max stress (MPa)	Former Temp ºC
One direction rotated	3.18±1.37	1574±81	0.328±0.105	67.7±8.79	15.2±0.16	75
Double straight dip	0.77±0.27	905±213	0.216±0.086	76.5±3.89	3.25±0.07	75
Multi-direction rotated	4.07±2.01	1500±302	0.486±0.153	65.2±10.6	20.1±0.19	75
Triple straight dip	2.94±1.23	1616±217	0.284±0.044	310.8±24.08	3.05±0.05	75





The two charts above show data from two of the trials. On the left is data from the procedure that created the most consistent film. On the right shows the former temperature that created the strongest films.

Discussion

Getting the film to spread evenly over the former was a challenge. Several different methods were tried. First the former was dipped and then spun in circles in the same direction. But that resulted in the middle of the former developing a thicker coat than everywhere else. So next, the former was dipped in the latex and not spun at all- it was just a straight dip. This worked better than the first approach but resulted in a allover bumpy texture. In order to fix that, three dips were used instead of two but that did not solve the problem. Finally, the former was dipped and then spun in alternating directions instead of the same direction of the first test- and this worked well in creating a uniform film.

There were also issues with data collection on the tensionmeter. First, the films being used were so thin that the tensionmeter had trouble detecting them. Manual force had to be applied to get the machine to start. In addition, there were problems with the clamps ripping the samples. The clamps contain ridges on them to keep the sample from slipping but these ridges were sharp enough that they would cut the sample, causing it to fail prematurely during the test. In an attempt to solve this problem cotton pads were placed on either side of the clamps to give the samples some cushion. While this helped the samples to stretch further before failing, it did not completely solve the problem as each sample continued to fail at its attachment point to the clamp.

This experiment is a part of a bigger effort to eradicate HIV/AIDS in South Africa. The big picture goal is to create processes that can be used there to create latex products in house and inexpensively.

References and Acknowledgments

- Cornish, K., Assessment of the risk of Type I latex allergy sensitization or reaction during use of products made from latex derived from guayule and other alternate rubber producing species. Rubber Science, 25(2): 139-155, 2012.
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