



Biometric Personal Authentic for Bio-Nonwoven Fashion : Biometric Personal (DNA ink) on Bacterial Cellulose Textile for Nonwoven Fashion Industry

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Abstract

Bio-nonwoven and Nanofiber fabrics of pure cellulose can be made from some bacteria such as *Acetobacterxylinum*. Bacterial cellulose fibers are very pure, 10 nm in diameter and about 0.5 micron long. The bacterial cellulose is similar to that of plant cellulose; however instead of being a product of plants, the cellulose was produced by millions of tiny bacteria from rice grown in Bioreactors LAB, providing an ecologically refreshing alternative to cotton or silk.

These fibers are very stiff and they have high strength, high porosity, and nanofiber structure. They can potentially be produced in industrial quantities at greatly reduced cost and significantly less water content, with triple the yield by a new process. The cost of production of the fabric is very low: one kilo of rice can produce up to 50 A4- sheets of fabric, thickness being around 0.3 mm. As an organic fabric, the impact on the environment is close to none. As far as durability is concerned, as long as it is preserved in a dry place, it could last forever, just like linen found on mummies in their tombs.

Development of biometric authentication technologies has progressed rapidly in the last few years. Personal authentication devices based on unique patterns of fingerprints, the iris, or subcutaneous veins in the wrist have been commercialized for personal use, such as in the verification of user log-ins at computer terminals. Facial recognition, voice dynamics, and handwriting analysis are also being used in criminal investigation. All of these methods of verification match analog patterns. Among the various types of biometric information, the DNA-ID presented here should prove the most reliable for personal identification. DNA information is intrinsically digital and does not change either during a person's life or after his or her death.

Today there are commercial, technological solutions available to provide a means to identify the supply of genuine products by using biometric DNA ink for authentication technology applied to the fabric.

Because direct dyes can be absorbed, the DNA ink can easily be added while the cellulose is produced.

The main purpose of mixing DNA ink with bio non-woven fabric is that, in the distant future, it could be possible to retrieve biometric personal information in such fabrics to recreate DNA from deceased people, and even be cloned if such technology is available. It could also be used in order to identify an artist's work: if each artist had his DNA information on his artwork, it could be then genuinely identified as authentic.

Keywords: Thai rice, Biometric Authentication, Bacterial cellulose, Green philosophy, Nonwoven fabric, Nanofibers, DNA, DNA-ID ink, Recycle, Sustainable

Introduction

Cellulose is the earth's major biopolymer and is of tremendous economic importance globally. Cellulose is the major constituent of cotton (over 94%) and wood (over 50%). Together, cotton and wood are the major resources for all cellulose products such as paper and textiles.

Among bacteria, one of the most advanced types of purple bacteria is the common vinegar bacterium, *Acetobacter*. This non-photosynthetic organism can procure glucose, sugar, glycerol, or other organic substrates and convert them into pure cellulose (Brown, et al, 1976). *Acetobacterxylinum* is Nature's most prolific cellulose-producing bacterium. A typical single cell can convert up to 108 glucose molecules per hour into cellulose. Consider the potential with as many as a million cells able to be packed into a large liquid droplet, and if each one of these cell-factories can then convert up to 108 glucose molecules per hour into cellulose.

A single cell of *Acetobacter* has a linear row of pores from which glucan chain polymer aggregates are spun. As many as one hundred of these pores can produce a composite cable of glucan polymers resulting in a ribbon. Time lapse analysis of individual *Acetobacter* cells assembling cellulose ribbons reveals a myriad of activities, each cell acting as a nano-spinneret, producing a bundle of sub-microscopic fibrils. This membrane of pure cellulose can be used for many exciting new applications. One of the unique features

of this pure cellulose membrane is that it is very strong in the never-dried state, as the fabric as long as it is not dried remains wet, and it can hold hundreds of times its weight in water.

Bacterial cellulose could be a material for clothes, shoes or accessories. Bacterial cellulose is already used for healing wounds and could in the future even replace bone tissue; and the material is absolutely sustainable.

Adding DNA ink to the fabric can become a key feature in the future to formally identify someone or even use the DNA information to clone someone, when the technology will become available.

Some people might also want to offer a special gift to their descendants by bequeathing a DNA-ink marked dress or bag, which is a unique legacy.

Growing Process

In order to grow the bacterial cellulose, one must brew a large batch of rice then add a few kilos of sugar and dissolve it in a container. The size of the fabric sheet is limited by the size of the container in which the mixture is fermented while stirring. When the temperature drops below 30 degrees Celsius (86F), one adds acetic acid and the bacteria.

The bacteria spins tiny threads of pure cellulose which, when left to ferment over time, come together in layers that form a mass on the surface of the liquid. Within 2-3 weeks this should produce an inch-thick sheet of cellulose fabric created from fermented yeast



Figure 1: The bacteria *Acetobacter* (starter) uses the sugar in the rice mixture to produce floating mats of cellulose



Figure 2: Keeping the bacteria afloat to enable it to access oxygen in the air.



Figure 3: Maintaining the container at a constant, but not very high temperature. It is important to watch for bubbles that indicate the fermentation process is active.

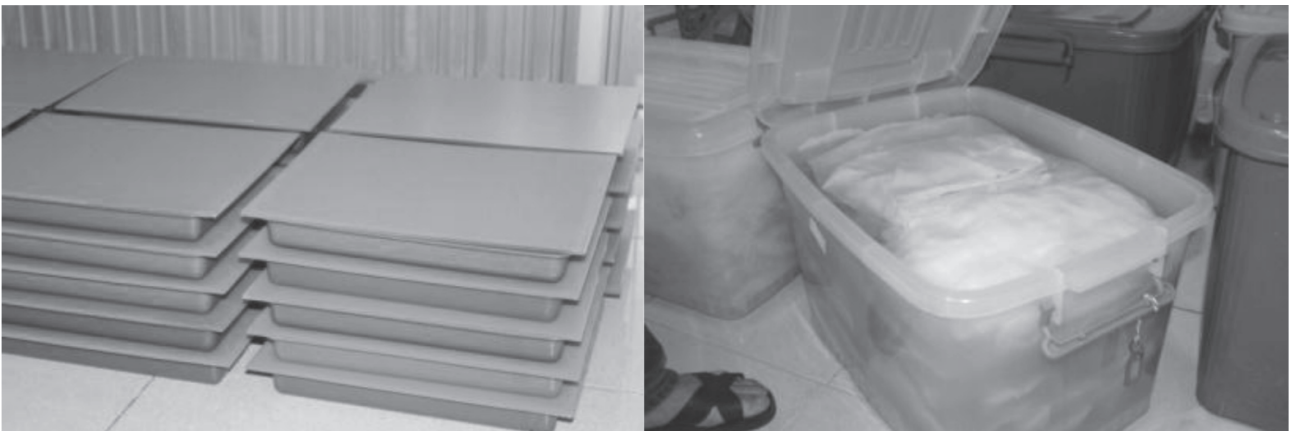


Figure 4: Maintain the container at a constant warm, but not hot, temperature

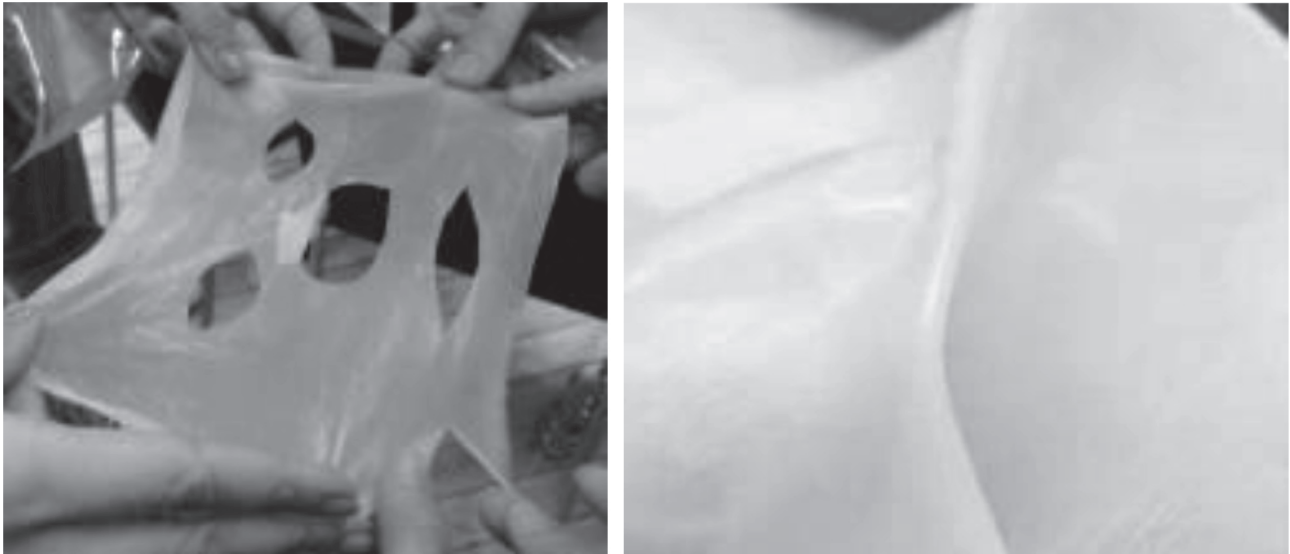


Figure 5: Sheet of wet cellulose after 2 weeks. It should be thick, slippery and full of water when lift it.



Figure 6: When dried, the cellulose will turn into a tough and see-through material, most easily comparable to a sheet of translucent paper, vegetable leather or even dried fruits.

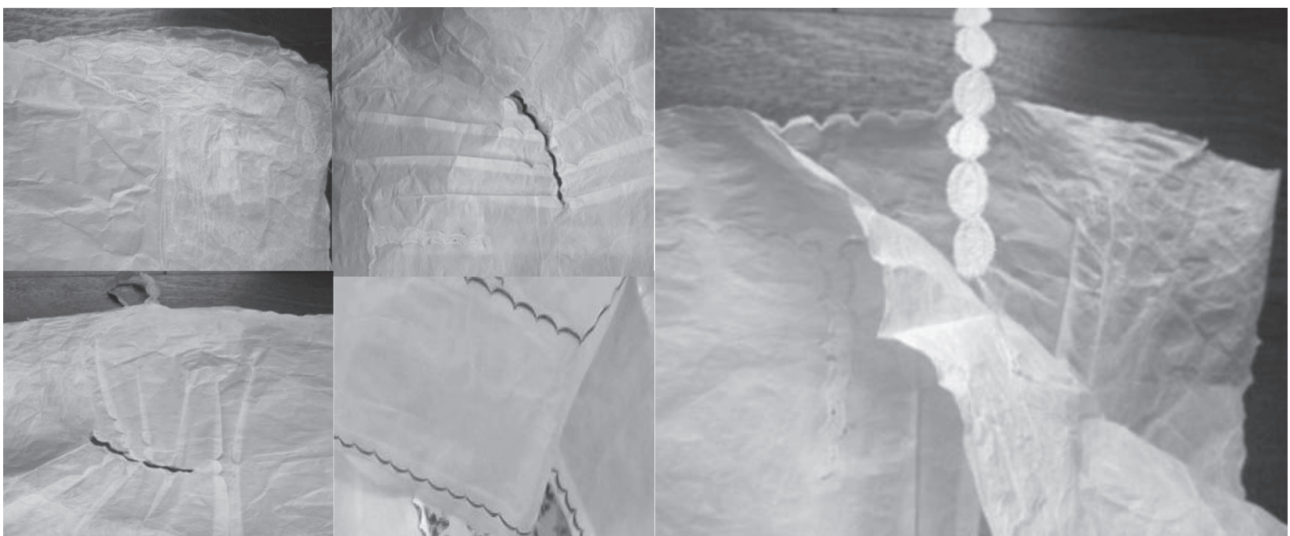


Figure 7: Skim the sheet off, then cut like leather when dry. Sheets of dried material remain that can be cut into patterns and sewn conventionally. The sheets while still wet can be formed around a mold such as a mannequin, to take the shape of the object.

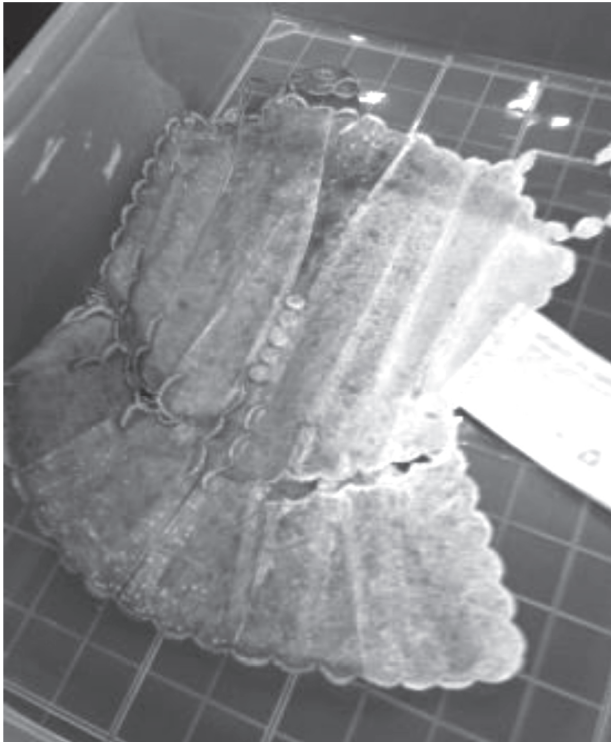


Figure 8: This dress is made out of 100% bacterial cellulose

and microbes on top of the liquid.

Dyeing Process

Because the microbial cellulose ribbons are spuné into the culture medium, membranes and shaped objects can be produced directly during the fermentation process, thus enabling a novel array of non-woven products. Direct dyes can be added during synthesis to alter the cellulose produced. The cellulose can be fermented in a colored solution to tint the fabric or can be dyed with vegetable stains afterward. Where cotton would require up to 18 dips in indigo to achieve a dark blue, the bacterial cellulose needs only one dip in indigo with beautiful results. This shows that the material soaks up the dye far more efficiently than does cotton, thereby conserving energy and materials. Aside from that, the results are gorgeous.

The experimentation of dyeing the fabric used

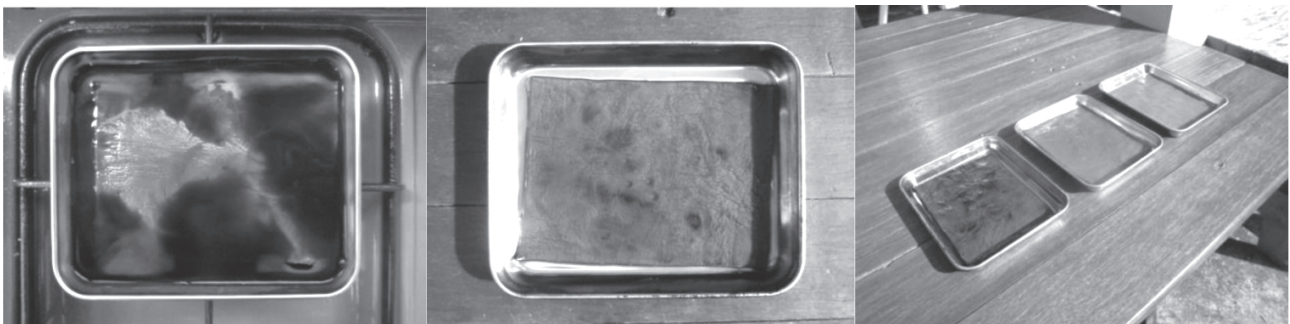


Figure 9: Indigo dyeing sample

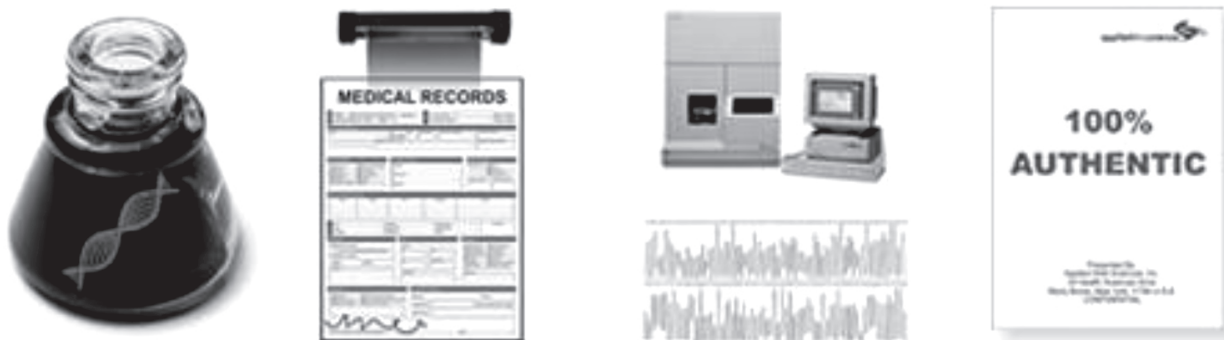


Figure 10: Plant DNA ink product of Nissha Printing Co., Ltd. and its group companies in Japan.

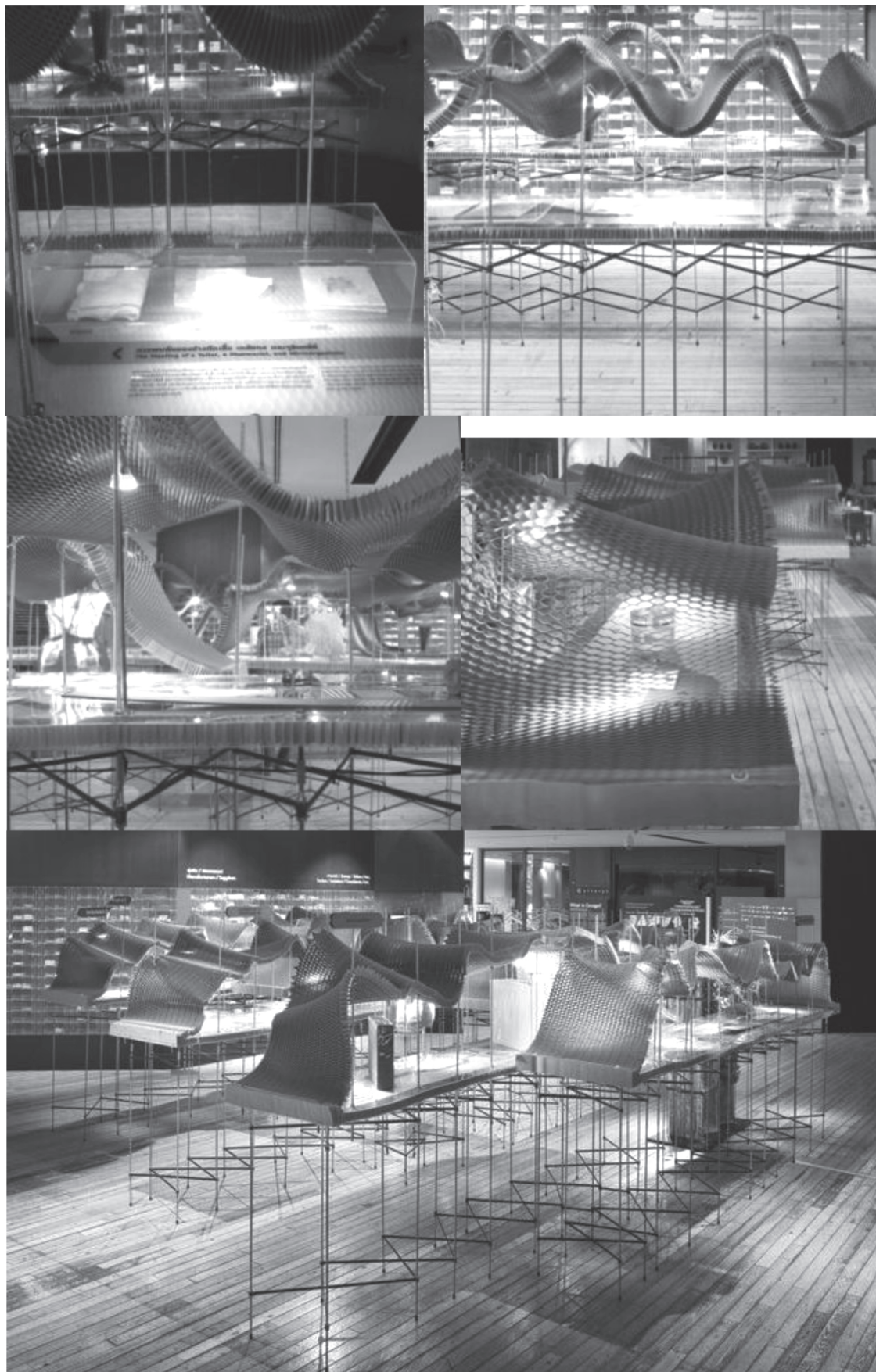
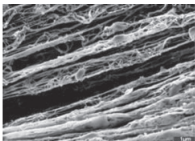
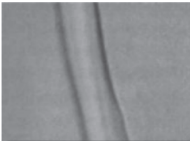
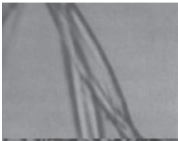
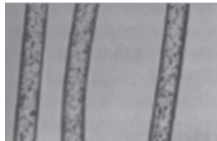
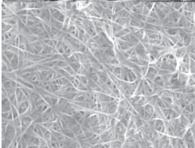
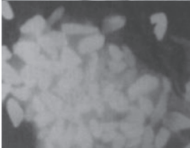
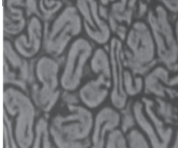
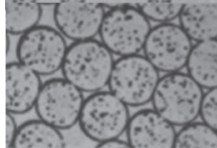


Figure 11: Siamese Twist exhibition: Experimental project with Material ConneXion Bangkok (Emporium) Project title: Bionic womenswear by Kris Yensudchai (22 November-28 December 2011)

Comparison of various features on bacterial cellulose between natural fibers and polyester.

Characteristics of the materials	Bacterial cellulose	silk	cotton	polyester
Viscosity (g /denyer).				
Strength dry	3.0-3.5	4.5	3.5-4.0	2.4-5.5
Strength wet	4.0-4.5	2.8-4.0	4.5-5.0	2.4-5.5
Density (g/cm ³)	1.10	1.25	1.52	1.34-1.39
Moisture absorption (%)	19	11	7-11	0.4-0.8
Extending percentage	35	20	3.7	18
Strength lost when it's wet (%)	50	30	9.5	18
Retracted after stretch of (%)	110	90	75	76
Resistance	medium	medium	medium	well
Heat resistance melting (c)	does not melt	does not melt	does not melt	249(c)
Bending	-	-	-	238(c)
Safe iron limit (c)	120(c)	149(c)	218(c)	163(c)
Flame reaction				
On flame	rapidly	slow	rapidly	melt and
Odor	paper burn	hair burn	paper burn	then burn slowly
Ashes	dark gray	black	light gray	toxic smoke dark brown
Elevation	bacterial cellulose	silk	cotton	polyester
Side elevation				
Top elevation				

only natural ingredients in keeping with the green philosophy behind the process. The next step is on developing ways to making the DNA dye process combined with growing the bacteria cellulose.

Material Analysis

The properties of materials and textiles made from fibers of various types.

Conclusion

In the era of declining forests, global climate changes, and continuing expansion of industrialization, it is reasonable to consider the consequences of decreasing availability of cellulose directly obtained from plants (such as wood or cotton) and the need for an alternative source of cellulose. We need to consider the various scenarios for the future of native

Poster size 42x30 cm.



Figure 12: Poster for Exhibition



Figure 13: Exhibition

biopolymers.

Bacterial cellulose has the potential to be incredibly versatile. If continued research goes well, it has great potential for many different uses. Given the characteristics of the materials, it might be possible one day to produce bacterial cellulose in different forms:

we could find ourselves in the future surrounded by bacterial cellulose products, such as 100% DNA authentic in our clothes, our shoes and bags. Even though this type of materials does not appear ideal for everyday wear, the possibilities for other uses are almost endless.

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