BACTERIAL CELLULOSE

Views Through Light and Shadow

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I. INTRODUCTION

Categorized as a biomateiral, Bacterial cellulose is a naturally derived construction element that can be implemented within the building fabric and is synthesized by bacteria.[1] This material is formed through the fermentation of kombucha tea, a beverage produced by colonies of bacteria and yeast. These organisms are embedded within a cellulose mat that forms on the surface of the beverage creating a network of fibers that make up the structure of this biofilm.[2] Although the resulting material harbors varying mechanical strengths, its translucent properties present potential uses as an alternative material in design endeavors. As a whole bacterial cellulose is able to create a relationship with light that emphasize textures, colours, and forms within a space.

The production of this material is one of the main objectives of a recent research group in the Department of Architecture, known as the BIOM_Lab. The BIOM_Lab is a preliminary study that revolves around the cultivation of bacterial cellulose, and mycelium, the network of roots produced by strains of fungi. Due to more frequent bacterial cellulose production, our efforts were shifted towards the manipulation of the mibcrobial films and their translucent characteristics.

1 Henriette M. Azeredo et al., "Bacterial Cellulose as a Raw Material for Food and Food Packaging Applications," (February 2019), https://doi.org/10.3389/fsufs.2019.00007.
2 Azeredo, "Bacterial Cellulose as Raw Material for Food Packaging Applications."

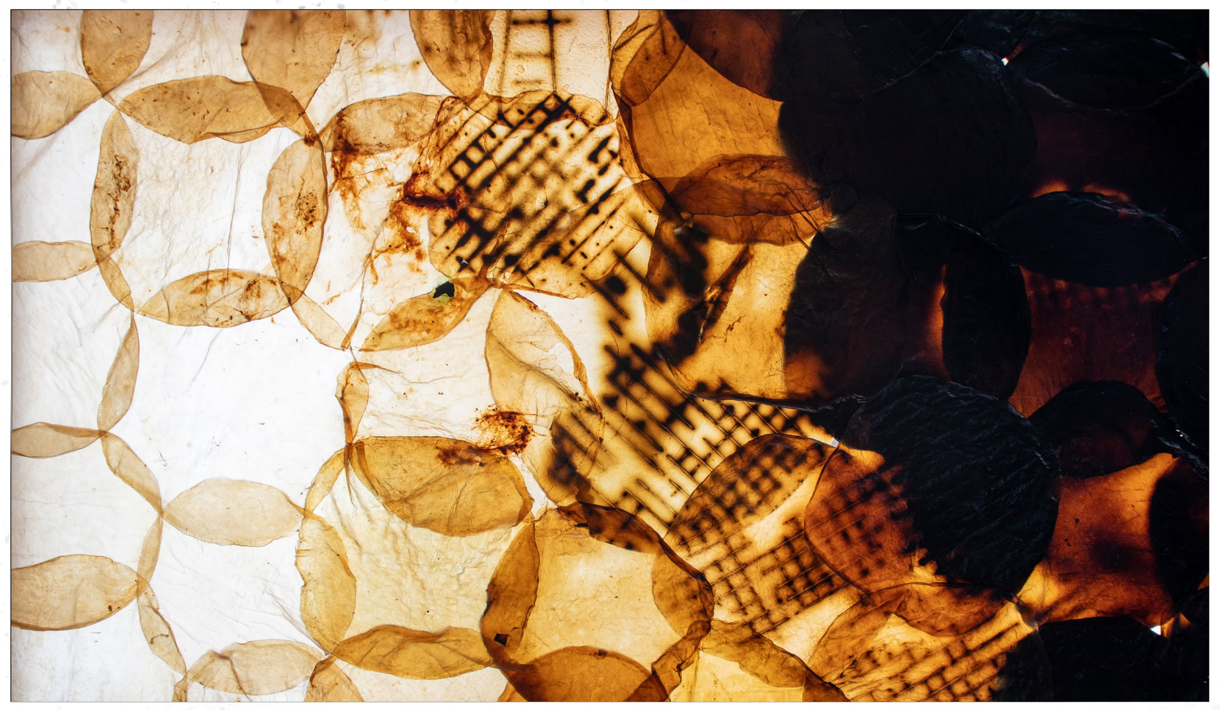

Fig 2. Bacterial cellulose panel made up of layer film demonstrating pontential of light and shadow

II. TRANSLUCENCY

With the BIOM_Lab team, there is an inherent fascination with the organic nature of the folds, culture residue, and imperfections of bacterial cellulose when exposed to light. The transparency of this film offers an opportunity to experiment with a material that harbors a sense of duality when viewed in front of a light source as opposed to without. The modification of its physical characteristics results in varying degrees of translucency that hint at the potential for selective experimentation (Figure 2).

These transformative experiments are mainly conducted through two methods - drying and dyeing. Drying methods pertains to the use of various drying surfaces and drying techniques, while dyeing methods branch into artificial and organic modes of dyeing samples. As a result, these methods become a means of intentionally hiding or accentuating the organic properties of the microbial films in order to fulfill an architectural intent.

III. DRYING METHODS

Drying methods are an essential factor in decerning the material properties of individual biofilm samples. For the purposes of light transmission, managing modes of drying are means of controlling the amount of light that passes through the material. Figure 3, for example, was hung and dried at room temperature causing the sheet to wrinkle upon itself due to the depletion of its moisture content. As a result, this drying method left unpredictable folds and patterns which are emphasized in the presence of light. It is also the most common and least energy intensive form of drying biofilms. On the other hand, drying alternatives like oxidation and oven drying are more immediate and time efficient.

Figure 3. Bacterial cellulose sheet hung and air dryed with batwing like texture and fragile

Fig 4. Oxidized bacterial cellulose sheet dried on a steel galvanized mesh

OXIDATION

The oxidation of bacterial cellulose is a chemical exchange between the water absorbed by the biofilm and the galvanized steel mesh that the material is dried on (Figure 4). Prolonged exposure to oxidation results in brittle films with obsidian marks left behind by the drying surface. This allows us to create interesting striations and gradients, which adds another layer of control to the amount of light that passes through the film. These synthetic patterns can then be implemented strategically to selectively block light from passing through specific areas on the surface of a bacterial cellulose sheet.

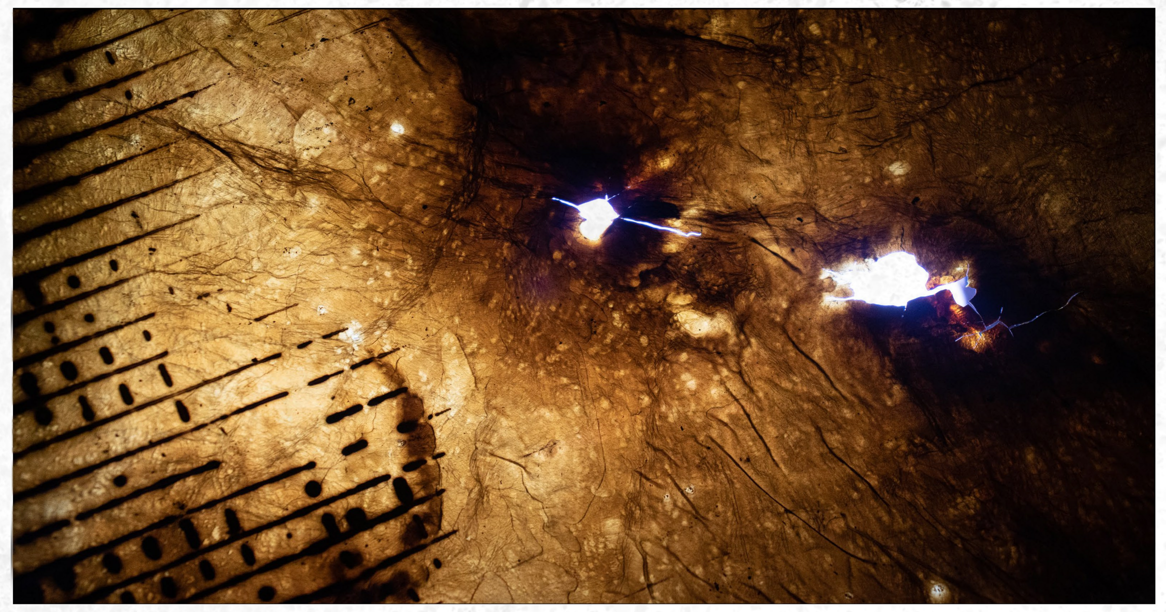

Fig 5. Bacterial cellulose sheet baked at 125°C for four hours

OVEN DRYING

Bacterial cellulose is also capable of withstanding oven temperatures for long periods of time. This method of drying is more energy intensive but greatly reduces the drying time from a few days to a few hours. Oven drying causes existing air pockets on the surface of the bio film to rise, and eventually burst when exposed to extensive heating (Figure 7). The resulting sheet resembles the charred texture of an oxidized sample with more apparent striations, but sacrifices its translucency rendering certain parts of the sample opaque.

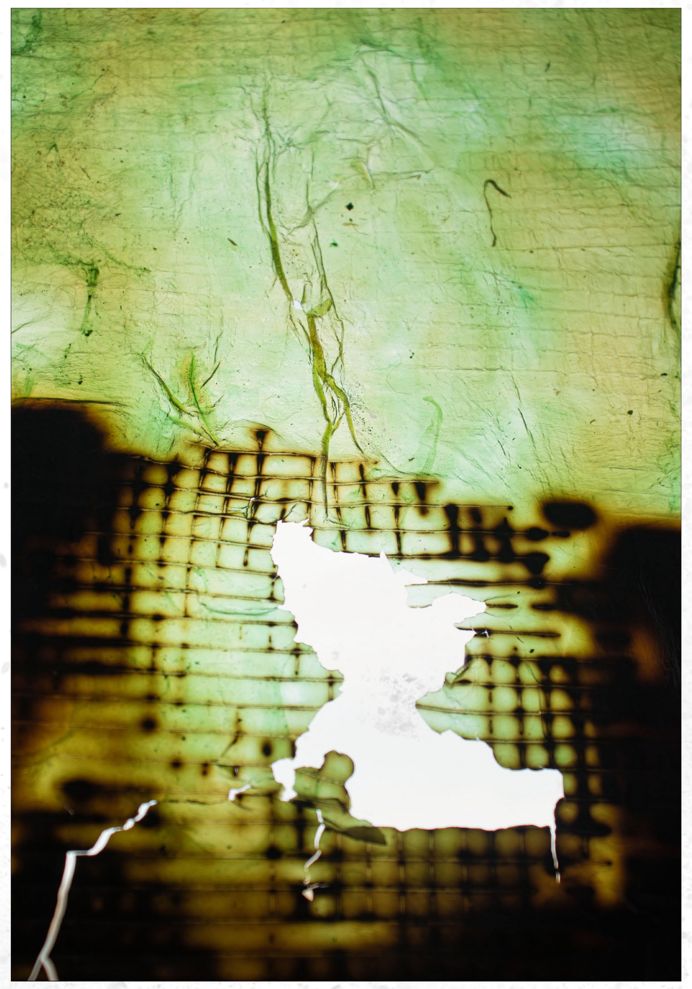

Fig. 7 Biofilm sheet dyed after harvesting

IV. DYEING

The BIOM_Lab team has also explored means dying through organic and artificial means. In the case of organic dyes, bacterial cellulose is grown in a culture medium composed of grape juice, sugar, and water. A harvested sample from this medium is relatively composed of clusters of colors that are minimally translucent. As a result, organically dyed samples are less tamed and inconsistent. However, from an aesthetic perspective, these colorful clusters are able to create visible contrast with remnants of the mother culture when exposed to light (Figure 6).

Artificial dying on the other hand is more consistent and permeable to light with little variation on the surface of dyed sheets. In that sense, this method of dying is more controlled and intentional. It also allows for selective dyeing resulting in hybrid samples which retain a portion of their original colour. Although the growing time of both methods are similar, due to the added moisture of artificial dying, the drying time of this method is extensive in comparison to an organically dyed sample. (Figure 7).

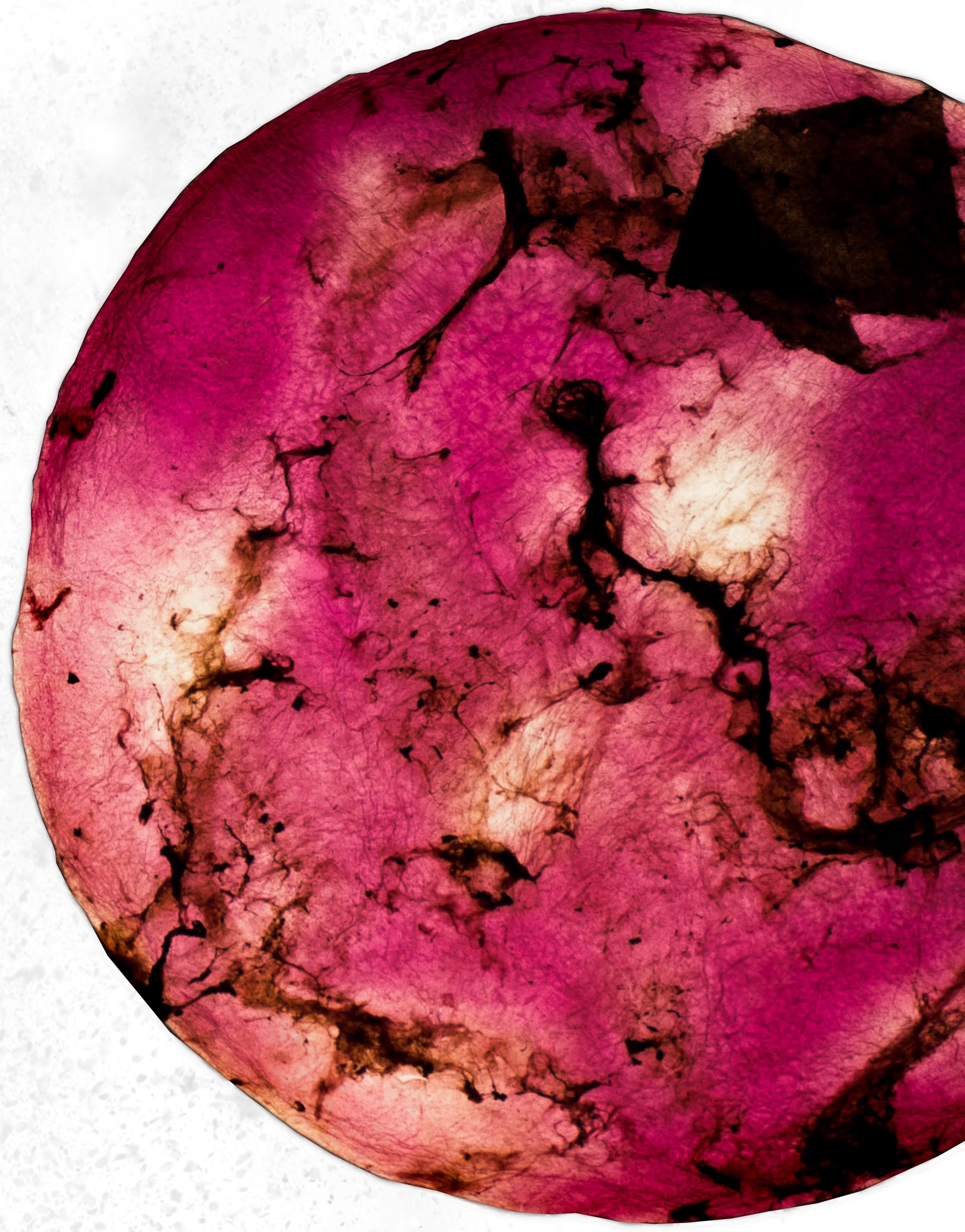

Figure 6. Biofilm dyed and grown in grape juice culture

Fig 8. A play on light and shadow - transluent properties of a bacterial cellulose panel

V. REFLECTING ON BACTERIAL CELLULOSE

As a whole, bacterial cellulose shows potential as an organic member of the building fabric. Imagine a structure that begins to break the line between the interior and the exterior of a space. It would simultaneously accentuate forms and textures of the building envelope as well as the spaces and forms within. Delving into the use of bio materials in architecture begins to question notions of a circular economy where reuse and decay are a consideration in a material's lifespan. However, in order to fully implement bacterial cellulose in architecture and design, it must be engineered to maintain functionality by withstanding the effects of extreme weather and the varying factors of the natural environment.