



Why Biofilm/ Bioresin?

From Plastic to Bioplastics

Plasticity in materials allows them to be cast, pressed, and extruded into a variety of shapes. A variety of natural materials with plasticity have been used throughout: bio-derived from egg and blood proteins, which are organic polymers or natural rubber made from the sap (known as latex) of a tree found in the forests of South America and Asia. Until today most common plastics are fossil-fuel plastics (also called petro-based polymers) which are derived from petroleum or natural gas - fossil resources that required decades or centuries to decompose. These plastics are classified by their structure acrylics, polyesters, silicones, and polyurethanes and upon their manufacturing process which require a lot of energy: thermoplastic, which can be extruded, reformed and remelted, and thermoset, which once formed cannot be remelted.

Due to fossil-fuel plastic's, up to now, low cost in manufacturing and its material versatility, it replaced wood, stone, leather, metal, glass, and ceramic and was used for mass production in products such as furniture, electronics, packaging, automobiles and building materials.

From Bioplastics to Biofilm/Bioresin

Plastics that are recyclable have been labeled Bioplastics in recent years. This represents often a "greenwashing" effort, disguising that the materials are not biodegradable, but rather a combination of plastic made from plant-based-cellulose with conventional petroleum plastics.

Whether bioplastics are degradable (i.e. broken down by metabolism of bacteria and fungi, that compostable and thus decay) or non-degradable (durable) depends on their molecular structure, not on the fact that biomass was their raw material.

Bioplastics can be produced from a variety of renewable biomass sources, such as vegetable fats and oils, algae/agar agar, corn starch, straw, woodchips, sawdust, recycled food waste, etc. Bioplastics are obtained by (1) processing them directly from natural biopolymers including polysaccharides (e.g. starch, cellulose, chitosan and alginate) and proteins (e.g. soy protein, gluten and gelatin), while others are (2) chemically synthesized from sugar derivatives (e.g. lactic acid) and lipids (oils and fats) from plants or animals, or (3) biologically generated by fermentation of sugars or lipids. An advantage of bioplastics is their independence from fossil fuel as a raw material, which is a finite and globally unevenly distributed resource that is linked to petroleum politics and the environmental impacts. Life cycle analysis studies show that some bioplastics can be made with a lower carbon footprint than their fossil counterparts, for example when biomass such as algae is used as raw material which is often also sequestering carbon creating a carbon negative product.

Biofilm/ bioresin can be poured, cast, pressed or extruded depending on the viscosity of the material before hardening. Consequently, there is a great variety of in its structural plasticity and transparencies depending on the ingredients and additives leading the creation of biofilm or bioresin. The fact that biofilm/bioresin is biodegradable and compostable makes them carbon neutral and creates to optoin of regenerative design.

Health & Safety:

Observe safety standards when handling plant based materials because some can cause allergic reactions. Beware of hot temperatures. Use stainless steel or wooden tools to not add to the coloring of the biomaterial.

Biofilm/Bioresin: Ingredients, Equipment, Assembly

Ingredients

Cold Water = 250 Milliliter (ml)

Agar Agar Powder 15 Gram (g) = 1 table spoon

Glycerol 15 Milliliter (ml) = 1 table spoon

Measurements conversion:

1 coffee/tea cup = 250 ml

1 table spoon = 15 ml or 15 g

1 table spoon = 3 tea spoons

Where to buy the ingredients:

Gelatin Powder can be bought at a food store.

Glycerol can be bought at a pharmacy.

Optional additive ingredients

Nature Dye (see nature dye protocol)

Ground plant based materials (mycelium, seaweed, egg shells, food waste such as fruit peels, seeds, flowers, leaves, etc.)

Note: All additives change the biofilm/bioresin's characteristics. The added amounts are experimental and could be started at 15 g.

Equipment

Cooking plate

Cooking pan or pot

Whisk or Spoon for stirring

Coffee/tea cup

Tea spoon

Table spoon

Container for sheet biofilm/bioresin OR

Mold for casting (glass, waxed paper/ cardstock, metal, 3D printed objects, waxed wood)*

**You can make a mold out of a variety of materials, but porous materials like wood or cardboard will have to be lined/waxed so your sculpture can easily be removed from the mold.*

Optional Equipment

Knife and cutting board for optional ingredients

Grinder for optional ingredients

Scale for more precision

Syringe for thread

Cotton, Canvas, Gauze or other fabric (for composite biofilm/bioresin)

Material Quality

Flexible to rigid depending on the amount of added Gelatin Powder or Glycerol:

The more Gelatin Powder you add, the harder the biofilm/bioresin.

The more Glycerol you add, the more malleable/ flexible the biofilm/bioresin

Making process:

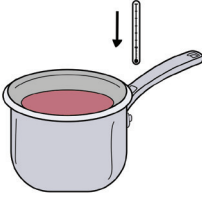
Casting, extruding, weaving, crocheting

Material assembly:

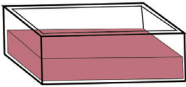
Sowing, pinning, fusion to fabric during drying

Biofilm/Bioresin: Step by Step Protocol

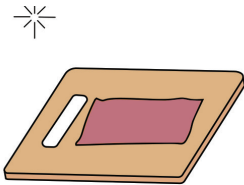
- Step 1



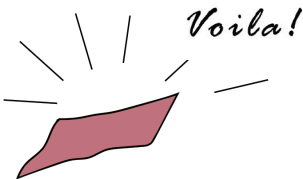
- Sheet: Step 2



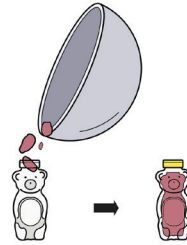
- Sheet: Step 3



- Sheet: Step 4



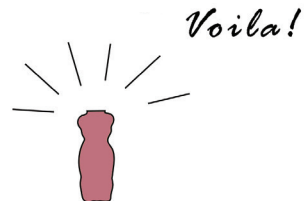
- Cast: Step 2



- Cast: Step 3



- Cast: Step 4



Biofilm/Bioresin: Step by Step Protocol

- Sheet: Steps 1-4

Step 1

- Gather all the materials you will need. In a small saucepan or pot bring 250 ml of water to a simmer.

Step 2

- Add the Agar Agar Powder (15g) and Glycerol (15 g) while stirring with a whisk and bring to a boil. Other additives are optional. Keep stirring until all ingredients dissolved.

Step 3

- Pour the well-mixed liquid into the mold tilting the container back and forth to evenly distribute the liquid across the bottom as it cools and thickens. Set the box aside for 2 or 3 days until the biofilm/ bioresin has dried.

Step 4

- After the biofilm/ bioresin has dried, use a small knife to separate the biofilm/bioresin from the edges of the container and peel off. The material will be quite rubbery or more resin-like depending on the thickness of the pour.

- Cast: Steps 1-4

Step 1

- Gather all the materials you will need. In a small saucepan or pot bring 250 ml of water to a simmer.

Step 2

- Add the Gelatin Powder (48 g) and Glycerol (12 g) the while stirring and bring to a boil.

Step 3

- Continue to stir and pour the well-mixed liquid into the mold filling it up completely. Set the mold aside for 2 or 3 days until the biofilm/ bioresin has dried.

Step 4

- After the biofilm/ bioresin has dried, use a small knife to separate the biofilm/bioresin from the edges of the container and peel off. The material will be quite rubbery or more resin-like depending on the thickness of the pour.

Reference Images:



Biorezin: Biorezin Jewelry designed by Degrade (Parsons Alum.)
www.degrade.center



Biofilm: Food packaging designed by Sara Selmić and Kelly Xi
https://www.saic.edu/news/students-create-plastic-packaging-alternative-sustainable-future?utm_campaign=later-linkinbio-biodesigned&utm_content=later-20584661&utm_medium=social&utm_source=linkin.bio



Water-resistant jacket designed by Charlotte McCurdy,
<https://www.charlottesmccurdy.com>



Biodegradable Water-Bottle designed by Ari Jonsson
<https://www.dezeen.com/2016/03/20/ari-jonsson-algae-bio->

Key References:

1. www.materiom.org
2. "The Secrets of Bioplastics", https://issuu.com/nat_arc/docs/the_secrets_of_bioplastic_
3. "Recipes for material", https://issuu.com/miriamribul/docs/miriam_ribul_recipes_for_material_a
4. "Bioplastic, Tools and Recipes", <https://issuu.com/johanviladrich/docs/bioplastic>
5. Parsons' Part Time Professor Oliver Kellhammer's Mycelium and Algae Biofilm pdf and biofilm_CA_video.mp4

Experiment Reflection:

1. How many days was it before your biofilm/bioresin dried?
3. Did you have any issues with the consistency of the biofilm/bioresin?
4. How might you prevent the consistency issue next time?
5. How might biofilm/bioresin be used as a replacement for nonsustainable materials in your chosen field of design?
6. In your opinion what are the variables impacting the process of making biofilm/bioresin? How does each variable impact the growth? How can you get a different result changing one of the variables while holding the others constant?
7. How might this protocol be improved? How might it be scaled up to grow bigger objects?

Your Experiment Log:

[illegible]

Your Experiment Reflection:

[illegible]

Glossary:

BIOFABRICATION: the production of complex living and non-living products by culturing organisms such as mycelium, bacteria and other microbes.

COMPOSITE MATERIAL: a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components.

MOLD (MOULD): a form used to cast sculptures and other shapes, and in this context, biofilm/bioresin. Often, it includes two parts so the object that is molded can be easily removed from the mold.

REGENERATIVE: processes that restore, renew or revitalize their own sources of energy and materials.

GENERATIVE: having the power or function of propagating or reproducing.

BIODEGRADABLE MATERIAL: a material that can easily be broken down into CO₂, water, energy, and cell mass with the aid of microbes. Biodegradable materials are largely carbon neutral.

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