# Reprogramming Matter : *Bioplastics*

Recipes, Protocols, and Reproducible Methods

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# Before
# *Starting*

This book does not offer definitive recipes, but starting points.
Bioplastic is neither perfect nor universal. It can be fragile and sometimes unpredictable.
Yet it is precisely within these limitations that it becomes interesting.

A bioplastic is a polymer material, meaning it is made of long chains of molecules, produced from natural, renewable resources such as starch, agar, or cellulose. It can serve as an alternative to petroleum-based plastics and is often biodegradable or compostable.

**What is it made of?**

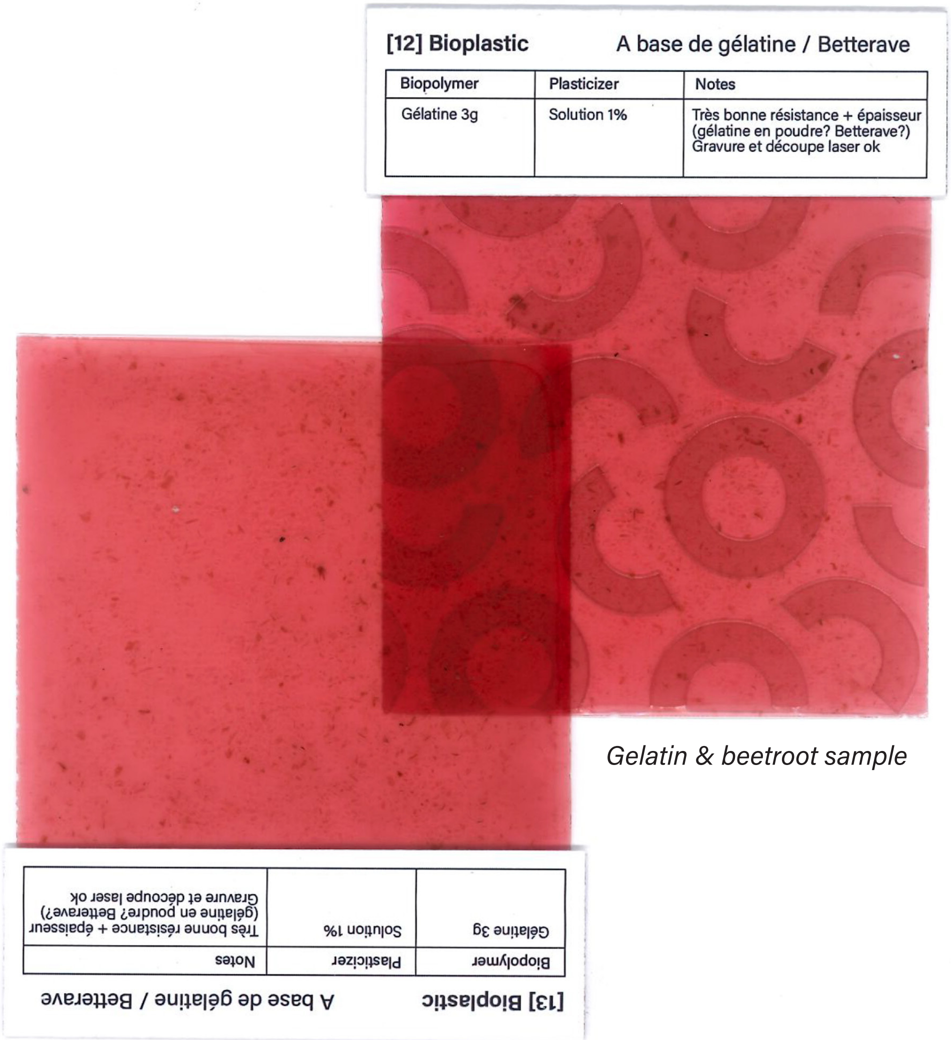
| Polymer | + | Plasticizer | + | A composite | + | Color |
|---|---|---|---|---|---|---|
| | | *For + or - flexibility* | | *Pour remplir / solidifier* | | |
| *- agar-agar*<br>*- gealtin*<br>*- starch*<br>*- etc* | | *- glycerin* | | *- fibers*<br>*- oils*<br>*- etc* | | *- pigments*<br>*- inks*<br>*- etc* |

**How does it work?**

**The solution is heated** – this mobilizes and denatures the polymer.
**The plasticizer** – inserts itself between the chains and forms secondary bonds.
**When cooled** – a network of flexible, elastic polymer forms, resulting in a bioplastic.
Fabriquer un bioplastique c’est comme faire de la cuisine !

**To know**

Each type of bioplastic (agar, starch, PLA, cellulose) has different properties, such as flexibility, transparency, and strength.
The proportions of polymer, water, and plasticizer (e.g., glycerin) have a strong influence on the outcome.
Drying time affects the final texture and rigidity.
For molds, glass, silicone, or acrylic are recommended.
Mechanical strength is lower than that of petroleum-based plastics.
Bioplastics are sensitive to moisture and can soften or swell when in contact with water.
Shelf life varies depending on the polymer and storage conditions.
Some bioplastics may have a smell from certain ingredients (vinegar, beetroot), which usually fades after a few days.




*Gelatin & beetroot sample*

# 1% solution

The 1% solution is the base for several recipes.
It is made of only two ingredients :

**Water : 1 L**

**Glycerin : 10 mL**

Store the solution in a sealed container in the refrigerator to prevent evaporation and the growth of microorganisms.

# x% solution

The glycerin content can be adjusted depending on the desired outcome :

**Water : 1 L**

**Glycerin : X mL**

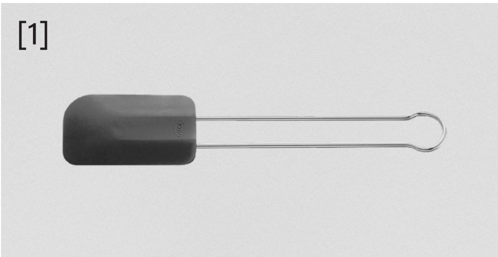
The more glycerin there is, the more elastic the bioplastic will be. Conversely, the less there is, the stiffer it will become. Note that other ingredients can also affect the final texture!

The 1% solution remains the most reliable compromise for achieving a flexible yet strong result in the recipes of this book.

# *Ustensils*

## Utensils for most recipes

| | |
|---|---|
| [1] 1 spatula | [6] 1 Oven mitt |
| [2] Mold(s) | [7] 1 saucepan |
| [3] 1 mixing bowl | [8] Small containers |
| [4] 1 hot plate | [9] Spoons |
| [5] 1 scale | |

[1]


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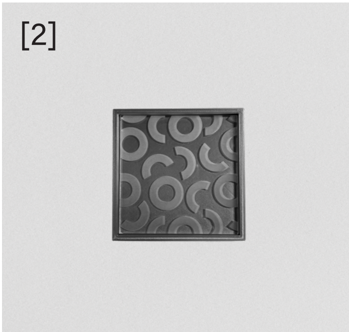


[3]


[4]


[5]


[6]


[7]


[8]


[9]


Recipes for a surface of approximately 18 × 18 cm

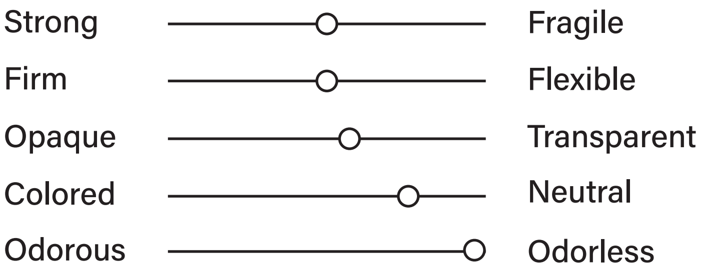

[3] Bioplastic
A base d'algues
Biopolymer
Plasticizer
Agar Agar 3g
base d'algues / test épaisseur
Notes
Plus épais
1%
[9] Bioplastic
A base d'algues / test motifs
Biopolymer
Plasticizer
Notes
Agar Agar 3g
Solution 1%
Plaque impression 3D:
Motif par net

# Agar-Agar

Agar-agar is a natural gelling agent extracted from certain red algae.

When heated with water and glycerin, the agar dissolves and then forms a solid network as it cools, while the glycerin keeps it flexible, thus creating a bioplastic.

[SUBJECTIVE MEASUREMENTS]




**Protocol :**
3 g of powdered agar-agar
160 mL of 1% solution

[1] Mix 160 mL of 1% solution with 3 g of powdered agar-agar in a saucepan.

[2] Heat on the stove (around 90 °C / 194 °F) for 3 minutes, stirring continuously. The mixture should foam.

[3] Pour the mixture into the mold(s). The solution will gel fairly quickly.

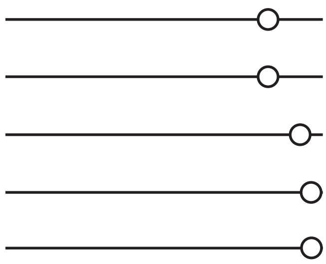
[NOTES]

# Gelatin
*Sheets*

Gelatin is a protein substance extracted, in the form of a gel, from certain animal tissues.

This recipe produces a very thin and elastic bioplastic, which can be compared to plastic wrap.

[SUBJECTIVE MEASUREMENTS]



| | |
|---|---|
| Strong | Fragile |
| Firm | Flexible |
| Opaque | Transparent |
| Colored | Neutral |
| Odorous | Odorless |

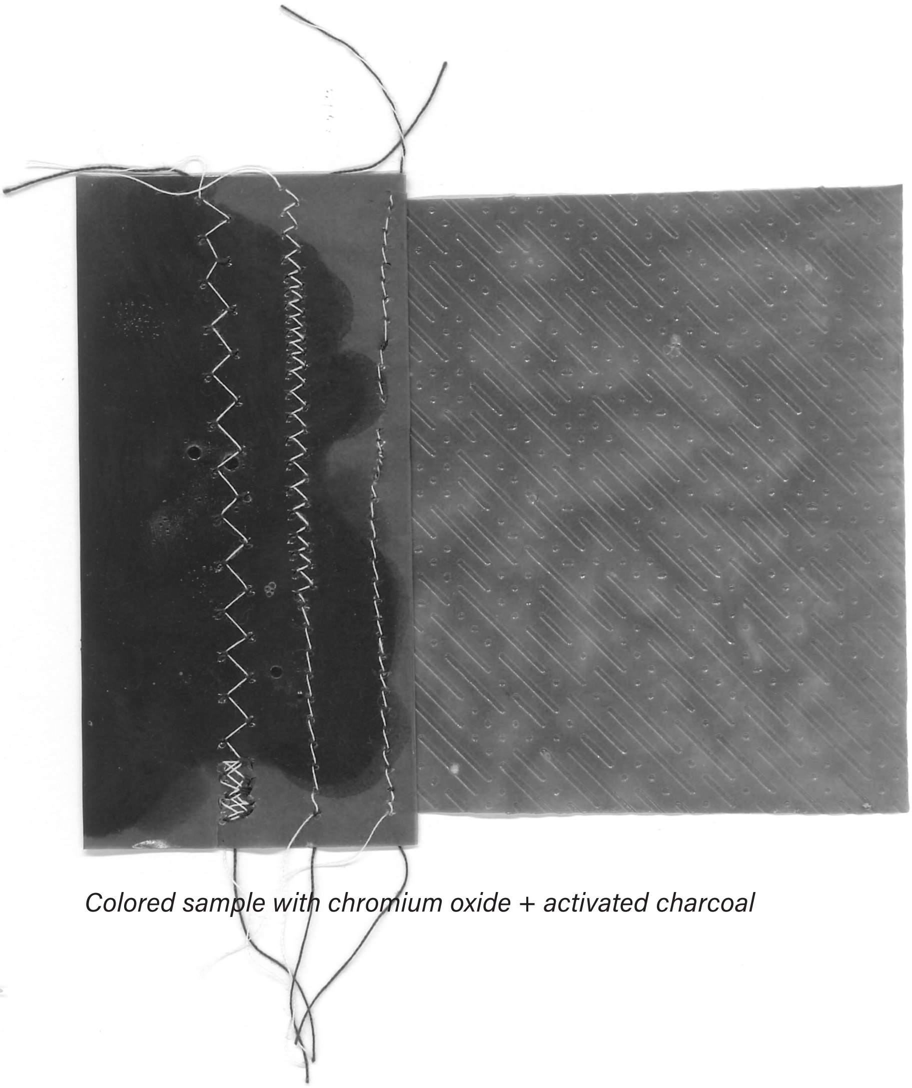
**Protocol :**
1 and a half gelatin sheets
160 mL of 1% solution

[1] Heat 160 mL of 1% solution on the stove (around 90 °C / 194 °F) until it simmers lightly.

[2] Add one and a half gelatin sheets, stirring until the gelatin is completely dissolved (about 5 minutes).

[3] Pour the mixture into the mold(s). The solution stays liquid for a while before gelling.

[NOTES]



*Colored sample with chromium oxide + activated charcoal*

# Powdered
*Gelatin*

Powdered gelatin is easier to measure accurately and is often more concentrated than sheet gelatin.

This recipe will therefore produce a stronger and denser bioplastic. I have not tested it without color, which is why there is no data on opacity or color.

[SUBJECTIVE MEASUREMENTS]

| | |
|---|---|
| Strong | Fragile |
| Firm | Flexible |
| Opaque | Transparent |
| Colored | Neutral |
| Odorous | Odorless |

**Protocol :**
3g of gélatin
160 mL of 1% solution

[1] Heat 160 mL of 1% solution on the stove (around 90 °C / 194 °F) until it simmers lightly.

[2] Add the gelatin, stirring until it is completely dissolved (about 5 minutes).

[3] Pour the mixture into the mold(s). The solution remains liquid for a while, so allow time for it to set.

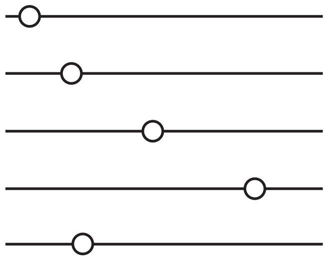
[NOTES]

# Corn
# *Starch*

Corn starch is a white powder extracted from corn, made up of two complex sugars (amylose and amylopectin), which thickens and gels when heated with water.

This recipe produces a thick and strong bioplastic, but it tends to form bubbles.

[SUBJECTIVE MEASUREMENTS]



| | |
|---|---|
| Strong | Fragile |
| Firm | Flexible |
| Opaque | Transparent |
| Colored | Neutral |
| Odorous | Odorless |

**Protocol :**

15mL of corn starch
100mL of water
10mL de glycerin
10mL de vinegar

[1] Mix all the ingredients.

[2] Heat the solution in a double boiler while stirring for about 6 minutes. The mixture becomes viscous.

[3] Pour the mixture into the mold(s). The solution is fairly thick, so you may need to spread it.

[NOTES]

*Stacked samples in front of a light*

# Powdered
## *Gelatin + beetroot*

Powdered gelatin is easier to measure accurately and is often more concentrated than sheet gelatin.

This recipe will therefore produce a stronger and denser bioplastic. Adding beetroot provides a natural pink color as well as a small amount of sugar, which can affect the texture of the bioplastic.

[SUBJECTIVE MEASUREMENTS]

| | |
|---|---|
| Strong | Fragile |
| Firm | Flexible |
| Opaque | Transparent |
| Colored | Neutral |
| Odorous | Odorless |

**Protocol :**
3g of powdered gelatin
160 mL of 1% solution
15mL of beetroot juice

[1] Blend the beetroot, then strain it through a sieve to obtain a smooth purée.

[2] Mix 15 mL of beetroot juice with 160 mL of 1% solution.

[3] Heat on the stove (around 90 °C / 194 °F). Add 3 g of gelatin, stirring until it is completely dissolved (about 5 minutes).

[4] Pour the mixture into the mold(s). The solution remains liquid for a while, so allow time for it to set.

[NOTES]

# Corn
## *Starch + beetroot*

Adding beetroot to a corn starch base produces a thick, naturally colored bioplastic. The pigment disperses unevenly, creating variations in color and a sometimes bubbly texture. The material tends to shrink as it dries.

[SUBJECTIVE MEASUREMENTS]

| | |
|---|---|
| Strong | Fragile |
| Firm | Flexible |
| Opaque | Transparent |
| Colored | Neutral |
| Odorous | Odorless |

**Protocole :**

15mL of corn starch
100mL of water
15mL of beetroot juice
10mL de glycerin
10mL de vinegar

[1] Blend the beetroot, then strain it through a sieve to obtain a smooth purée.

[2] Mix all the ingredients.

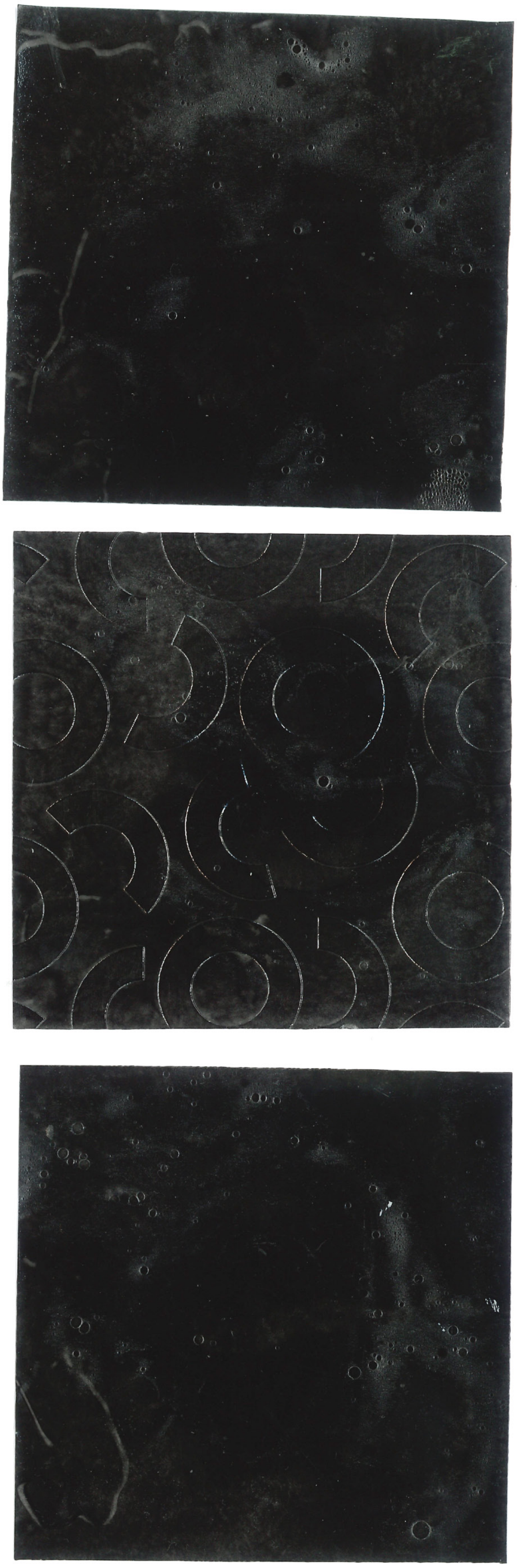
[3] Heat the solution in a double boiler while stirring for about 6 minutes. The mixture becomes viscous.

[4] Pour the mixture into the mold(s). The solution is fairly thick, so you may need to spread it.

[NOTES]

# *Pigments*

As seen previously with beetroot, it is possible to color bioplastics. For obvious reasons, we only use natural pigments here, which will not interfere with composting the product. It is also possible to use fruits and vegetables, or even spices.



*Activated charcoal samples*

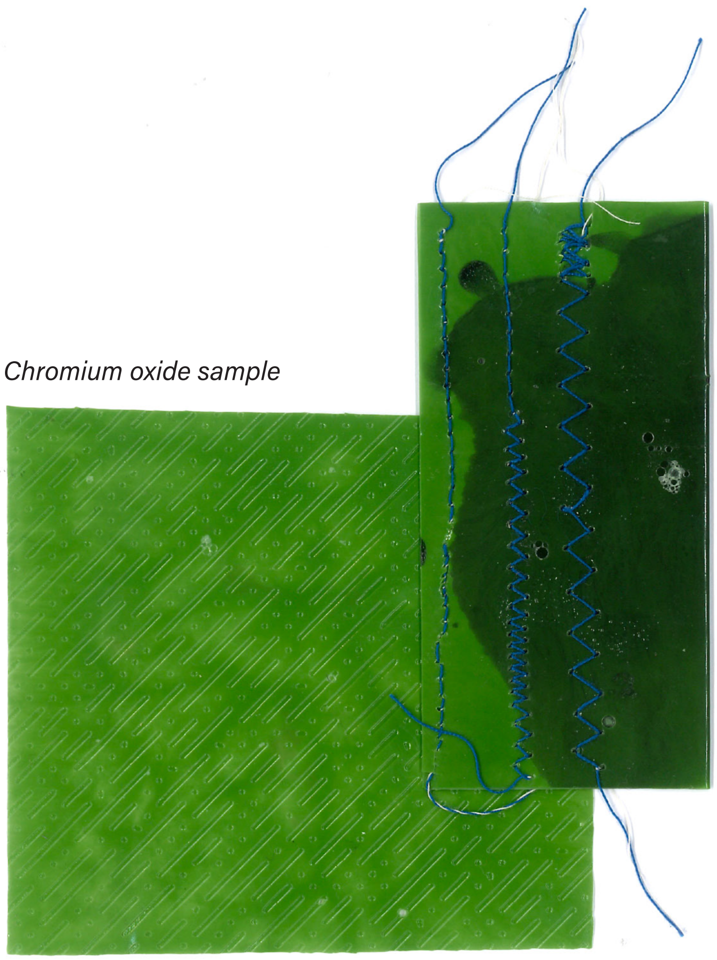
**Powdered gelatin**
**+ Activated charcoal**

Activated charcoal is a powder made from plant-based carbon, non-toxic and highly porous, obtained through thermal activation.
In bioplastic, it provides a black color, strengthens the material, helps absorb moisture and odors, while preserving the material's compostability. This pigment significantly changes the texture of the bioplastic, making it much firmer.

**Powdered gelatin**
**+ Chromium oxide**

Chromium oxide is an inert, non-toxic, and very stable mineral pigment, used to provide a long-lasting green color.
In bioplastic, it gives a green color that is resistant to light and heat, does not react with the material, and still preserves compostability.

*Chromium oxide sample*



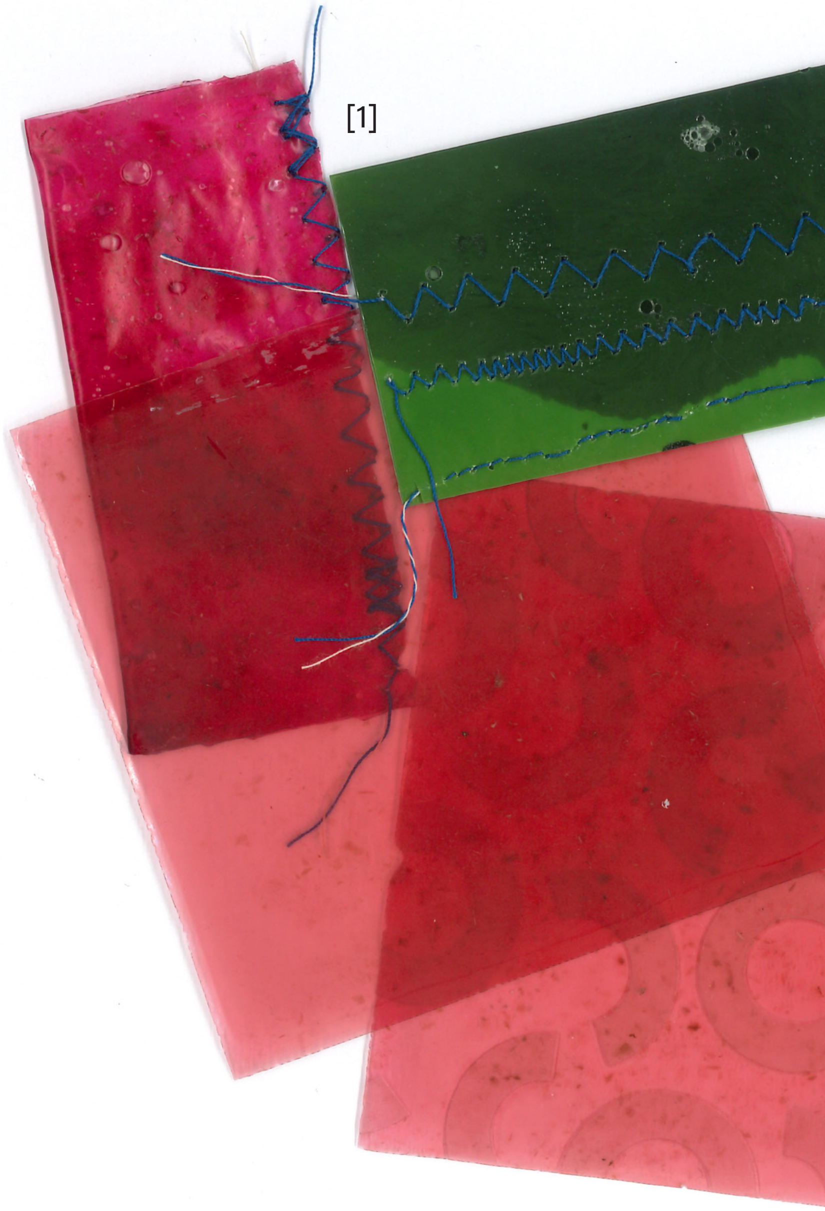
*Chromium oxide + activated charcoal mixture*

# Material
# *Tests*

To understand the potential of this new material and imagine relevant uses, I tested it through various experiments.

The goal was not to impose a specific function on it, but to observe how it behaves when treated as a material in its own right, like leather, textiles, or industrial plastics. These experiments reveal its limits, but above all, its unexpected qualities.

Some bioplastics can be pierced, sewn, and assembled. Sewing allows us to explore the material's flexibility, its tensile strength, and how it behaves around stitch points. [1]


[1]

[2] [3]

[2] Laser cutting offers high precision and allows the creation of complex shapes, while engraving reveals how the material reacts to heat: contrasts, reliefs, and color variations. These tests are particularly useful for imagining decorative or functional applications.

[3] Even before demolding, the bioplastic can already carry a graphic intention. The textures and patterns in the mold transfer directly to the material's surface, with no additional steps. This is a simple and effective way to integrate the design into the manufacturing process itself.

These tests show that bioplastic is not a fixed material. Depending on its composition, thickness, and method of fabrication, it can be cut, assembled, textured, or decorated. Exploring these uses opens up a world of possibilities and allows each recipe to find its ideal application.

# To *Conclude...*

By making your own bioplastic, you shift your perspective: you are no longer just consuming a material, you are understanding it.
You observe it, adapt it, and question it.

Now it's up to everyone to experiment, transform, and repurpose these recipes.
To find new shapes, new uses, and new stories for them.

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