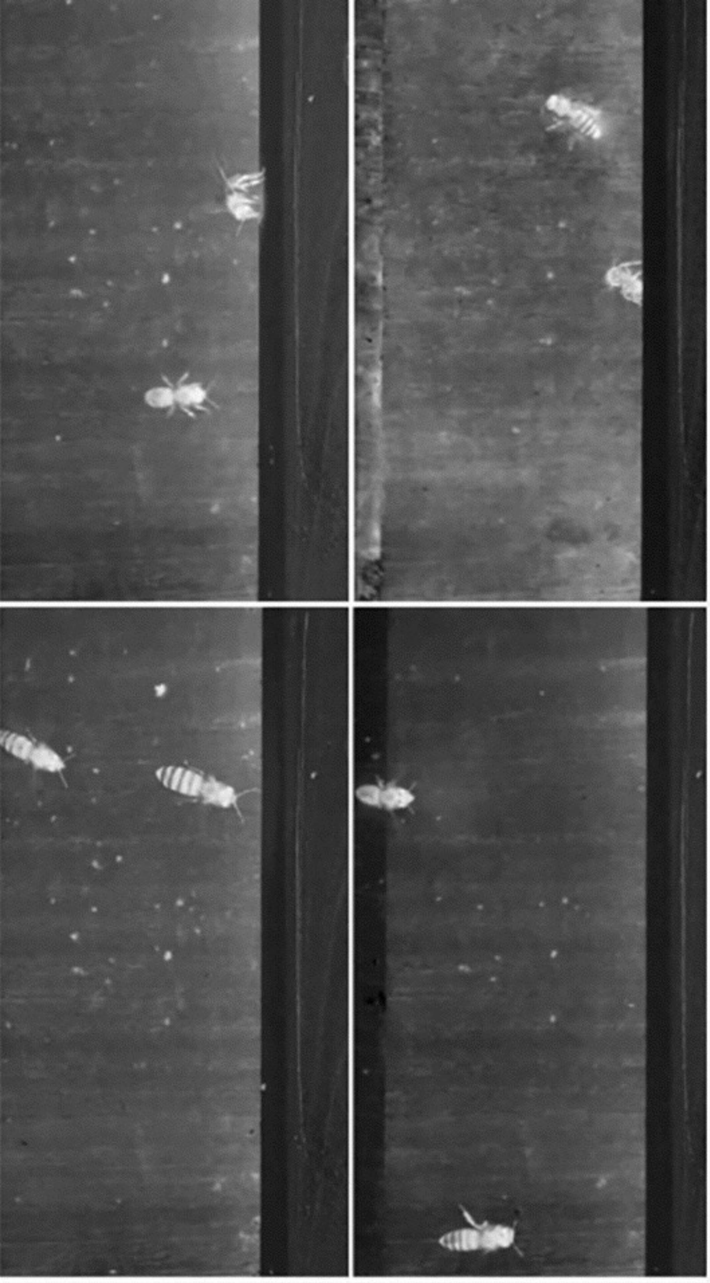
SENSORIAL SKIN FOR AN INTELLIGENT GUERILLA BEEHIVE

an artistic research project to support honeybee colonies in decline

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I am an artist and a beekeeper. In my Urban Bee Lab I examine the behaviour of honeybee colonies in relation to the environment.
Their daily actions are at the center of my artistic research and a source of inspiration for my artworks.

With the *Transparent Beehive* and the *Sound Beehive* projects I studied the development of a honeybee colony through its own sound.
The buzz of a colony and its behaviour and conditions are quite related. It is possible to know if a hive is queenless or if an important amount of nectar has been collected simply by listening to the sound of the hive.

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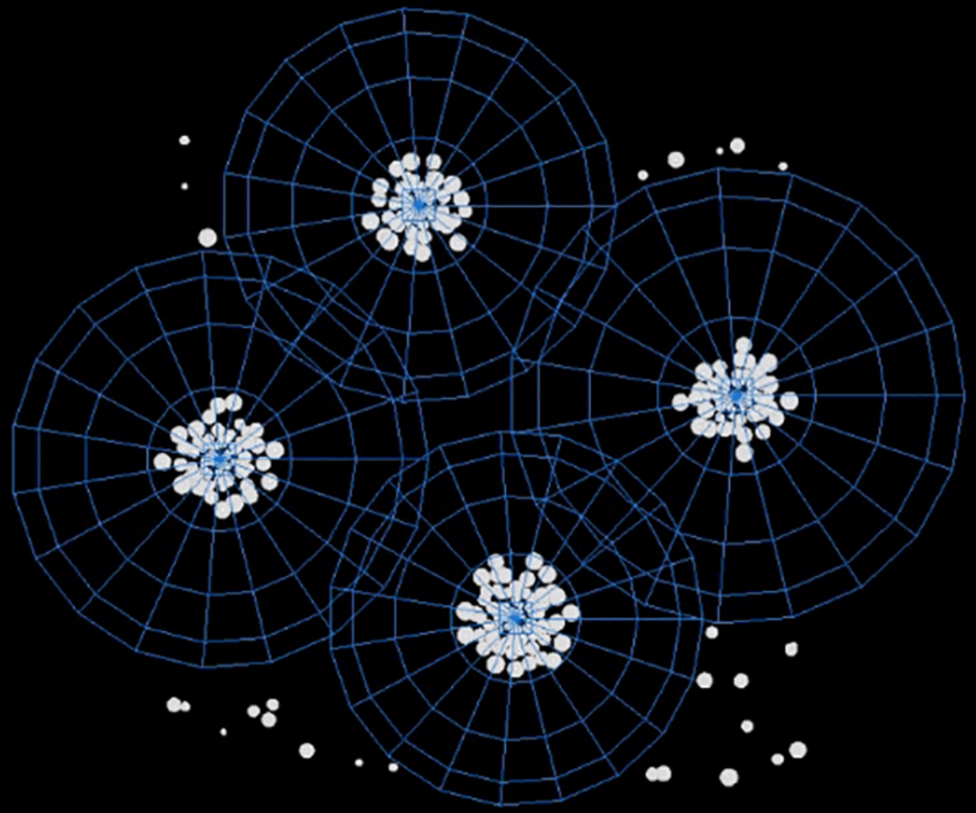

SENSOR DATA:
AUDIO BRIGHTNESS + HIVE TEMPERATURE + MOTION TRACKING

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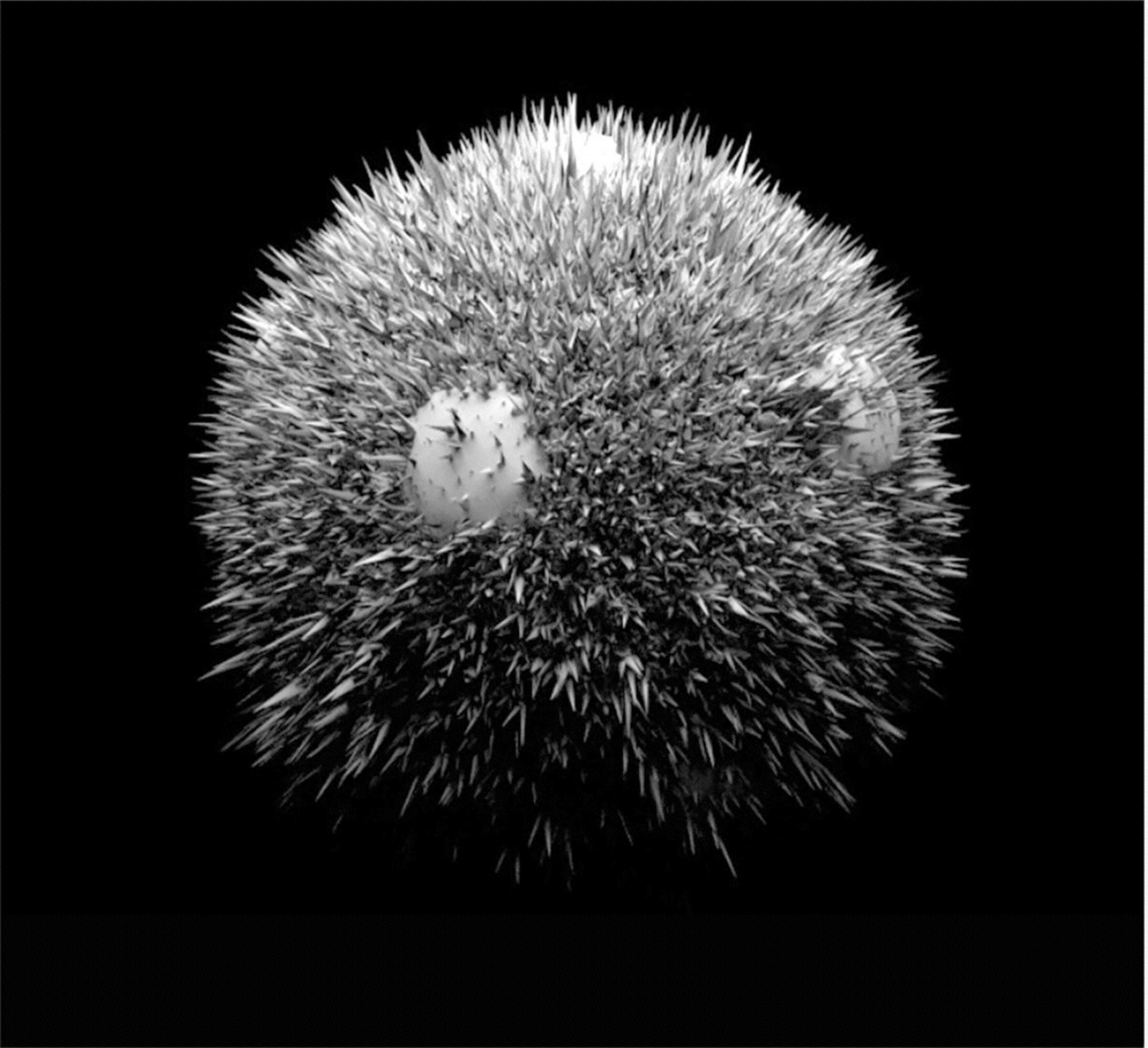
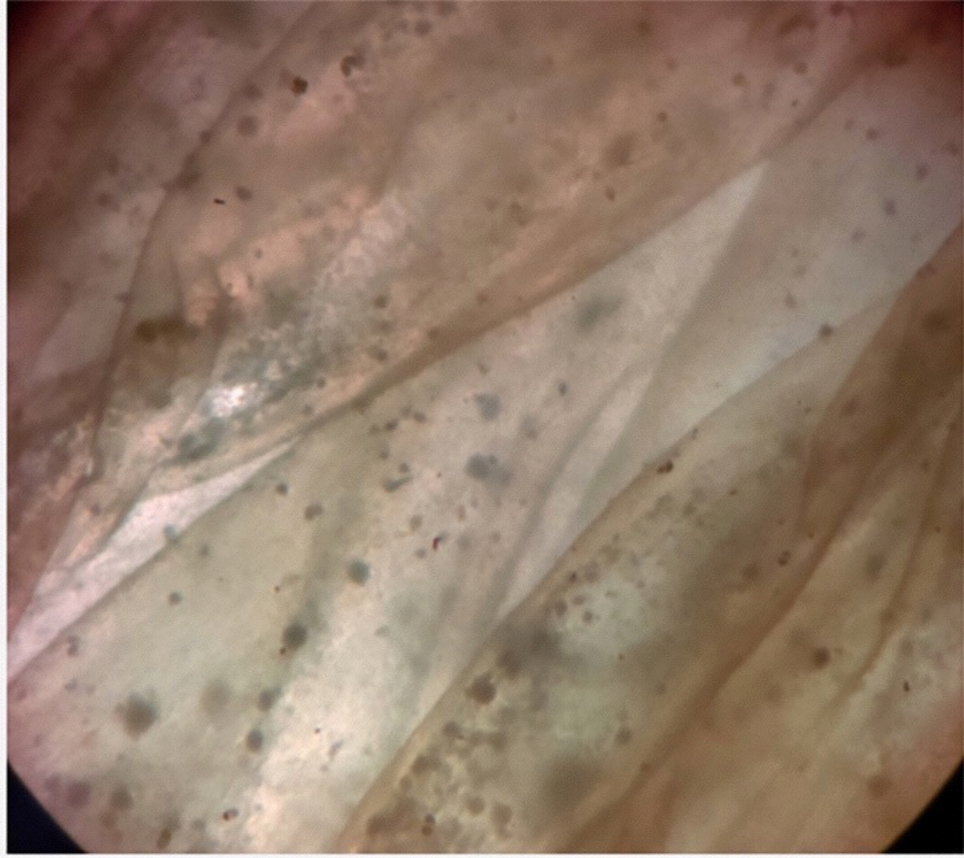
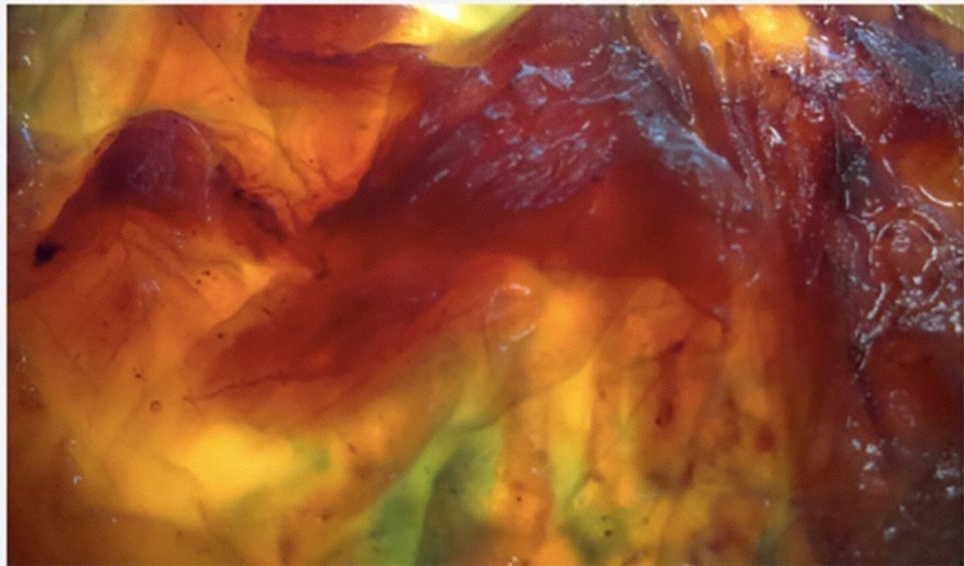
SENSOR DATA:
AUDIO BRIGHTNESS + HIVE TEMPERATURE + MOTION TRACKING

Customized open source hardware and software was developed in order to continually monitor the sounds and to film on different spots in the beehive.
I followed a systemic approach to raise understanding of the characteristics of the colony through relationships with its environment, and through patterns discovered in the collected audio, video and sensor data, as well as through contextual observations.
The data were processed using sophisticated pattern recognition, AI technologies, and graphics software.
The project included an experiment in using Deep Learning to interpret the activities in the hive based on sound and microclimate recording.

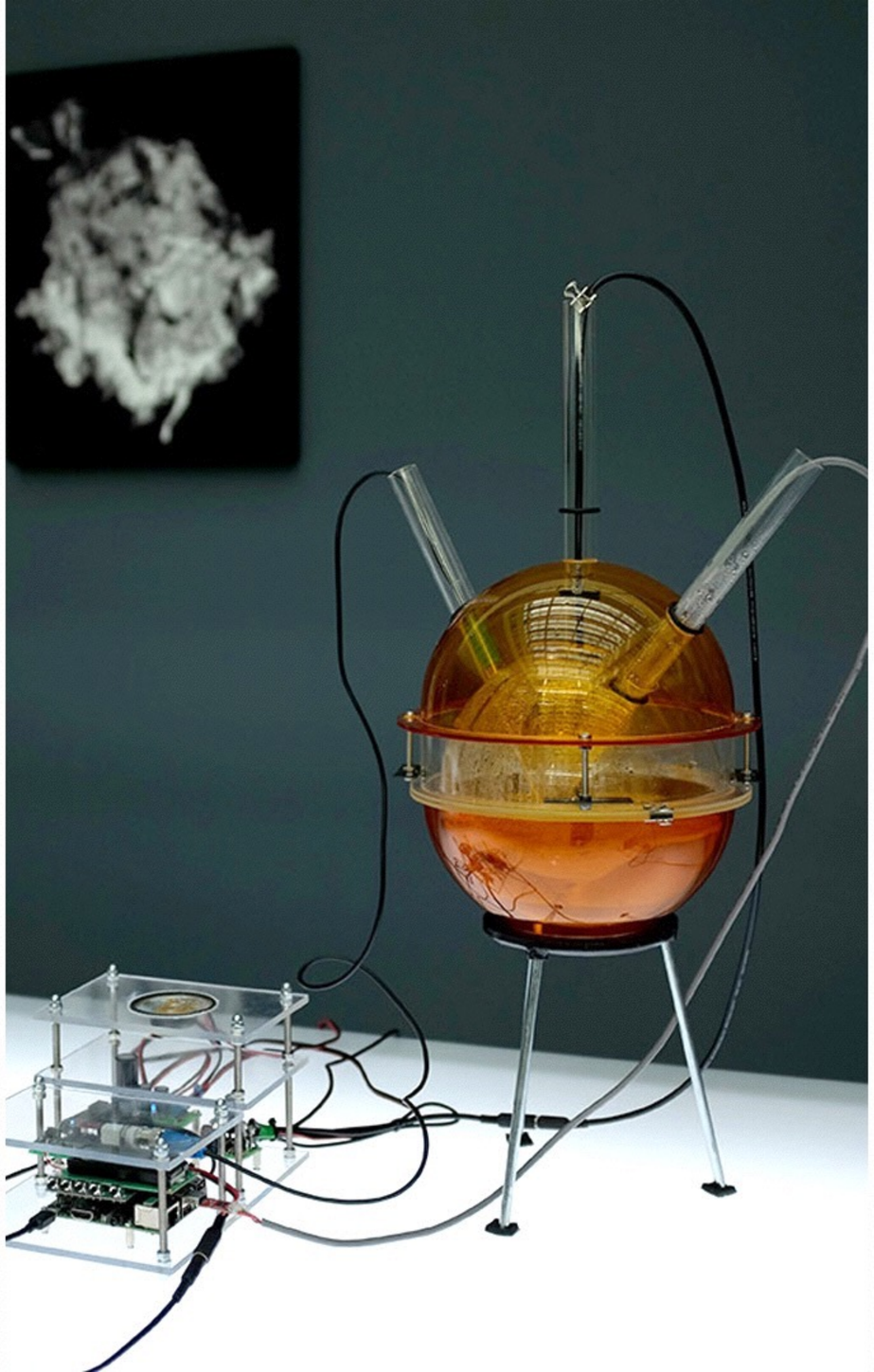
The Intelligent Guerilla Beehive is a biotech project. It is the third generation in my series of observation devices. This refuge for swarming honeybees is a mobile (guerilla) double sensing device.
It is mirroring the health status of the environment and that of the bees living inside the hive. Colonies of color-changing bacteria, living on the outer skin of the hive, send out warnings at high environmental pollution. The inner skin is a host for colonies of symbiotic bacteria that support a healthy bee microbiome. It is a radically new beehive designed for urban environments.

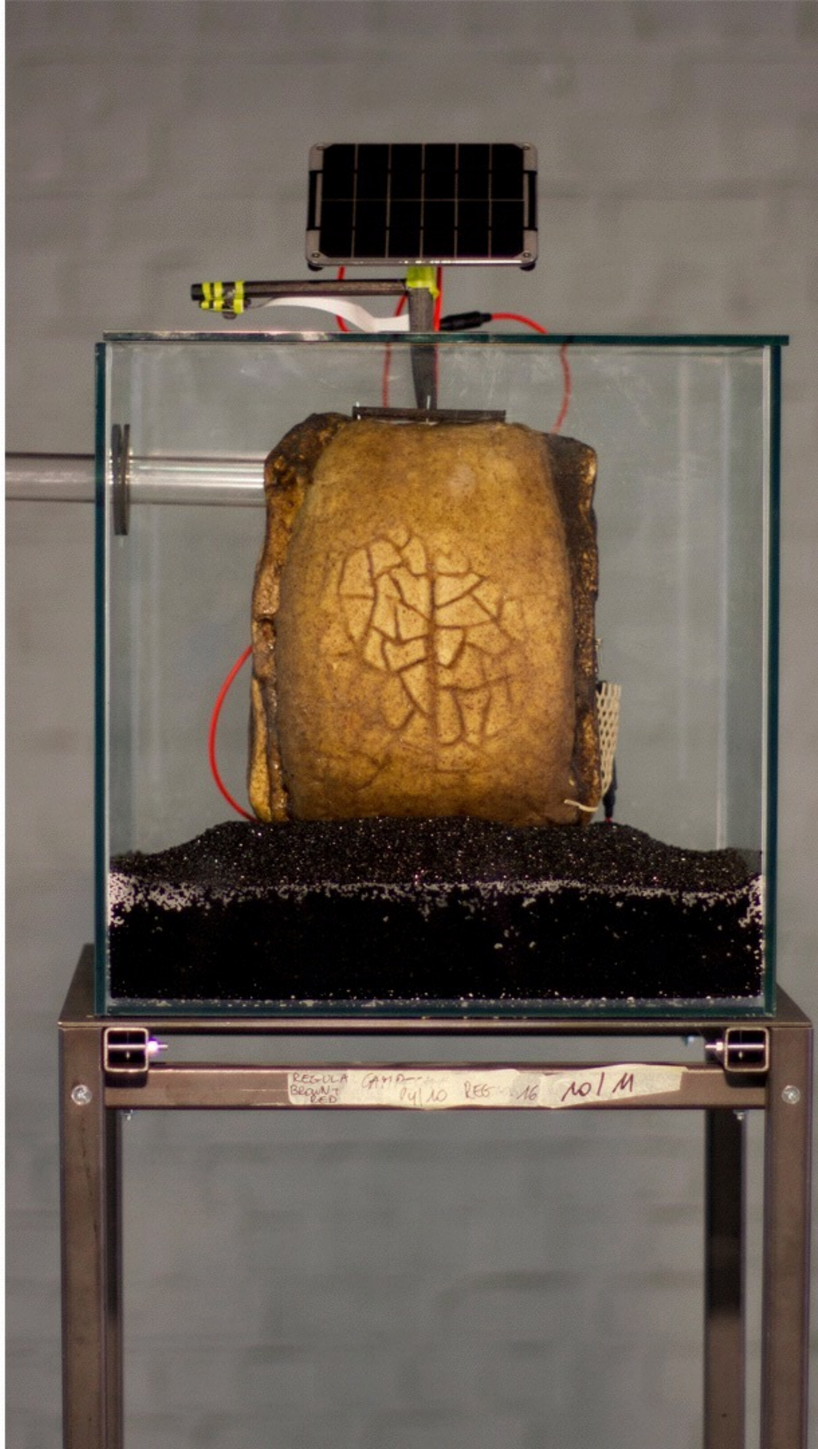




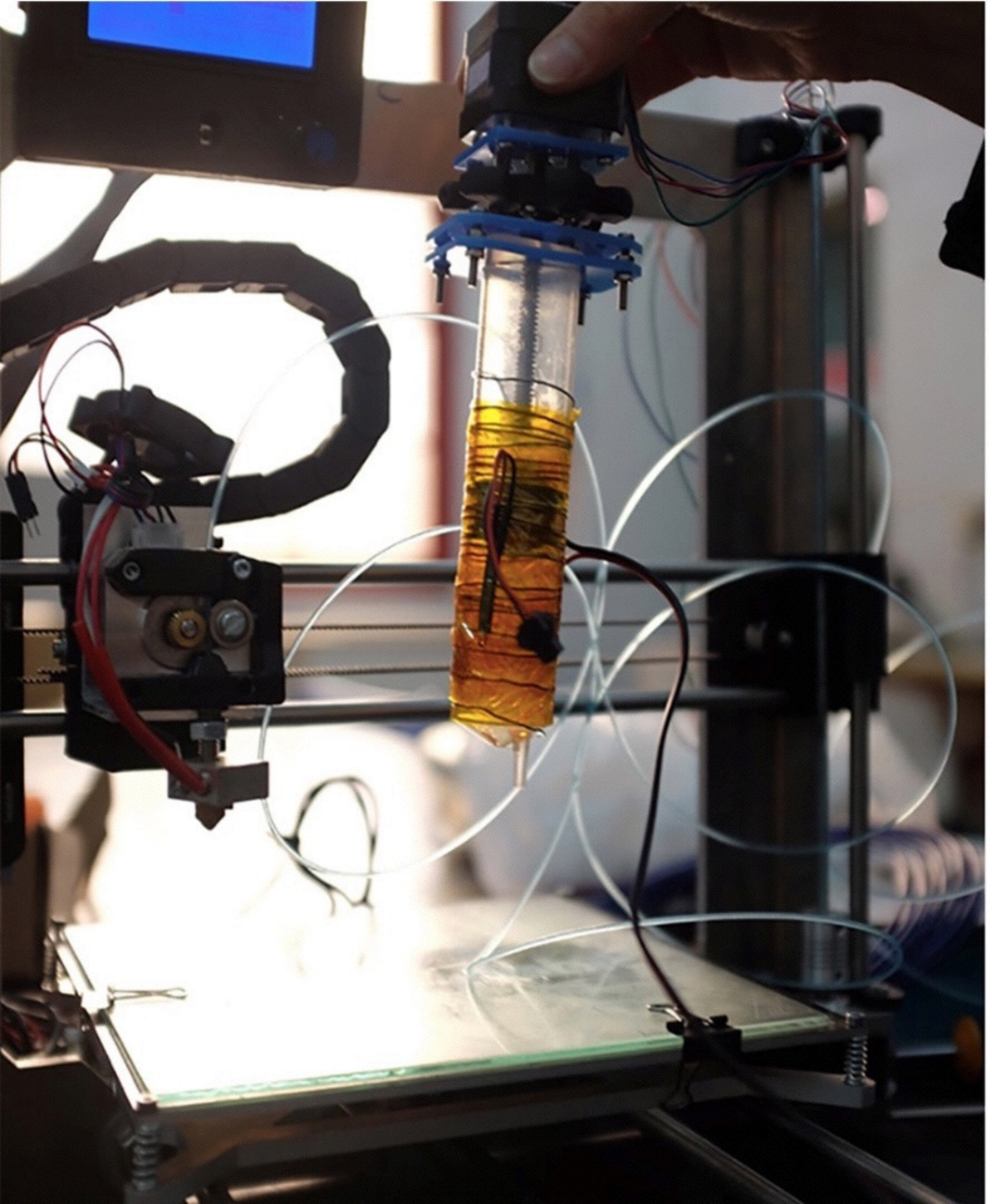


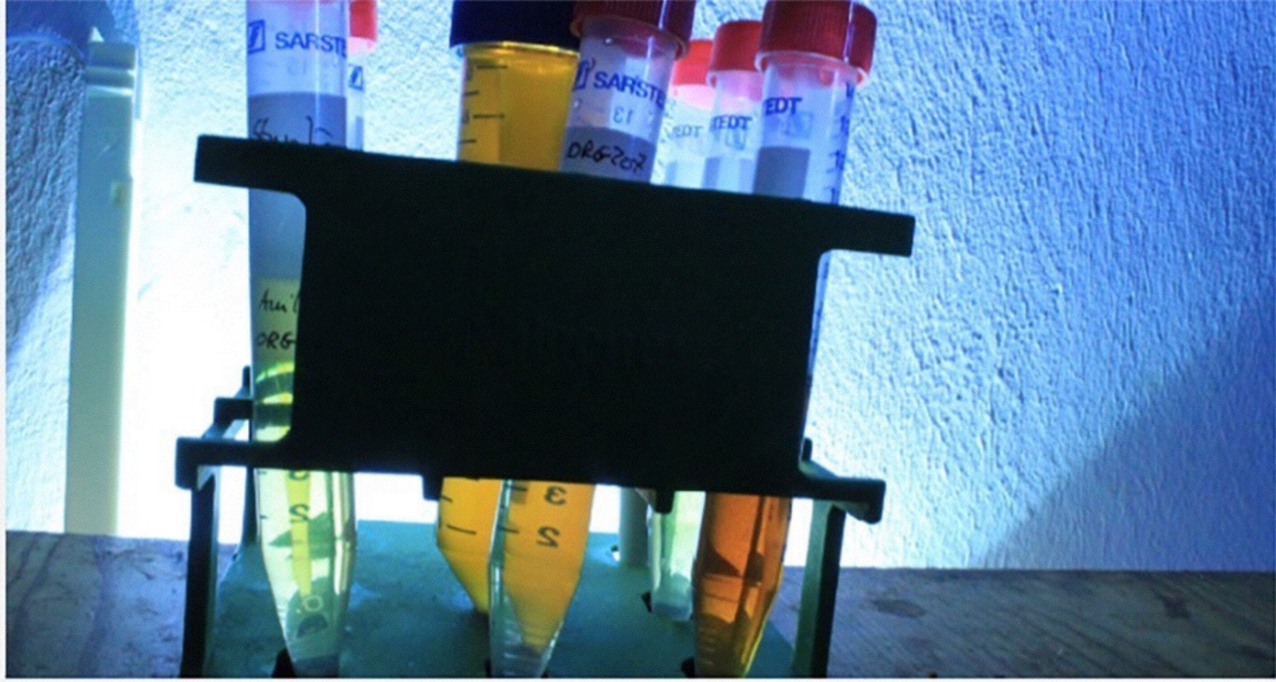
Biomimesis is used as inspiration for incubating ecological thinking on matter and form for the development of the new hive.
Palynology -the study of spores and pollen grains- offers a good starting point for the research. Different sensorial qualities are being examined in terms of usefulness for sensing environmental threaths. On top of their interesting adaptive and defensive qualities on micro- and nano-scale, the pollen shapes are of an extreme aesthetic beauty.
The determination of the pollen which are brought by the bees to the hive can help us to map problems in the foraging areas of the bees, as pollen contain useful information on the environment.





The next step was to translate these biotechnological qualities and to implement them in the primary materials that are used to build the beehive.
I decided to focus on a few organic materials that are largely available on earth: cellulose and chitosan. I started my experiments to grow cellulose-based biofabrics and leather-like membranes with bacteria and other micro-organisms. I studied the development of this matter and explored its possibilities to support the bees.
In collaboration with scientists we decided to augment these cellulose skins with living monitoring technology in the form of bacterial biofilms.

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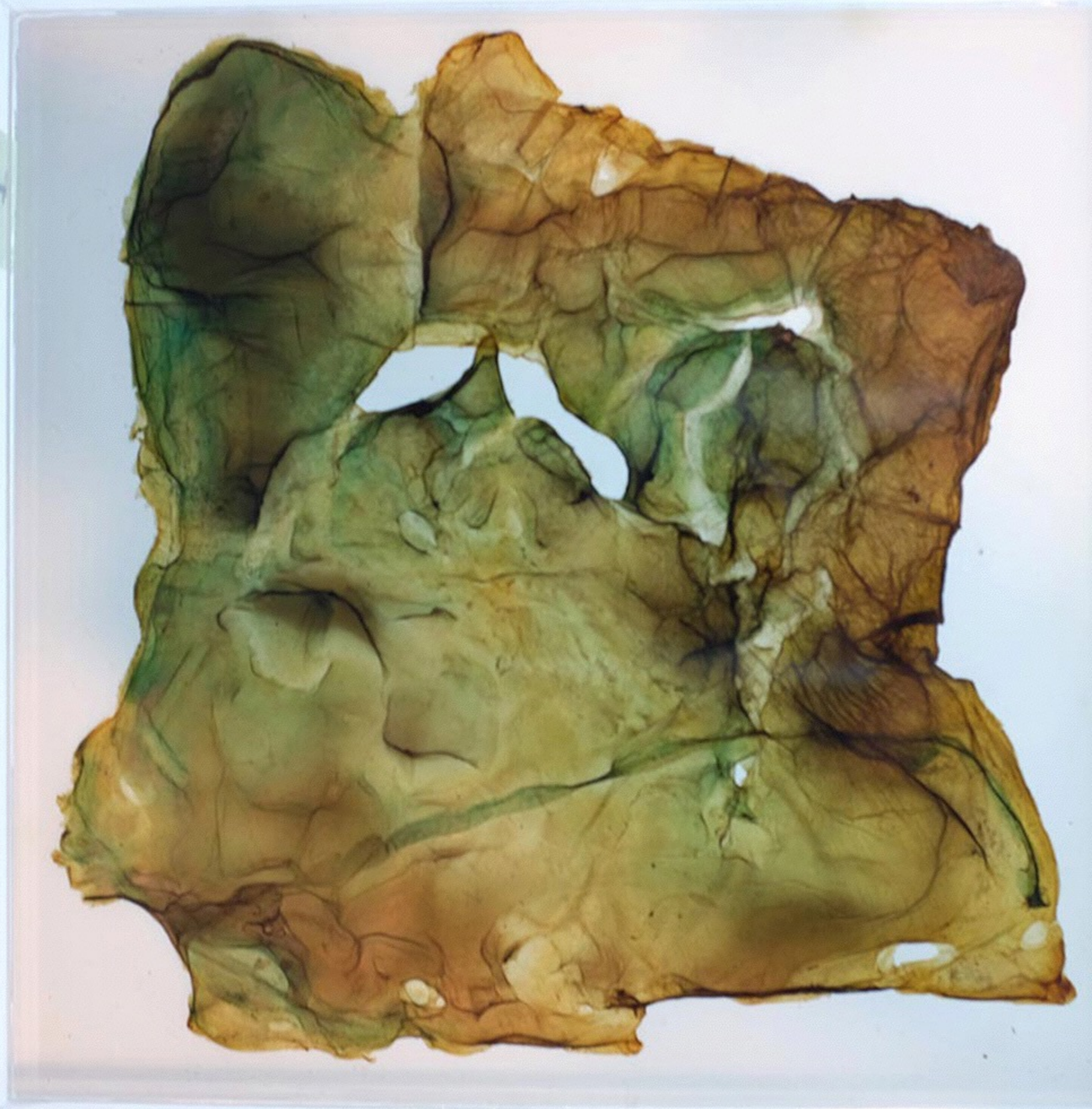
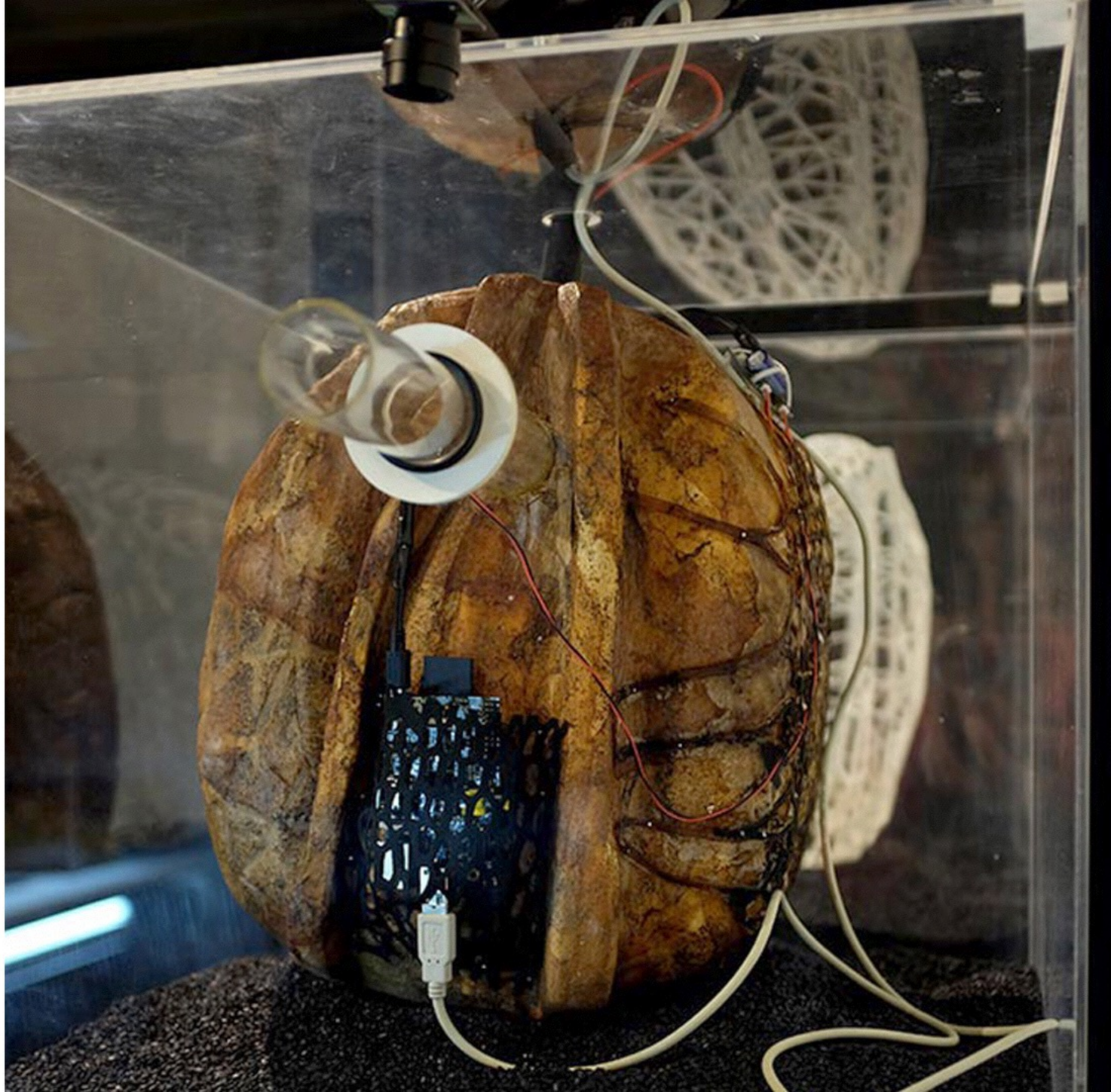
In the biohacklab we researched different strains of appropriate micro-organisms.
We experimented with colonies of bacteria to turn them into biosensors.
We implemented the biofilms populated by useful microbes for environmental sensing (*Deinococcus radiophilus*) on the leathery cellulose skin of the beehive.
The colonies of bacteria are designed to sense environmental pollution and they will change color when they discover a specific pollutant in the air.

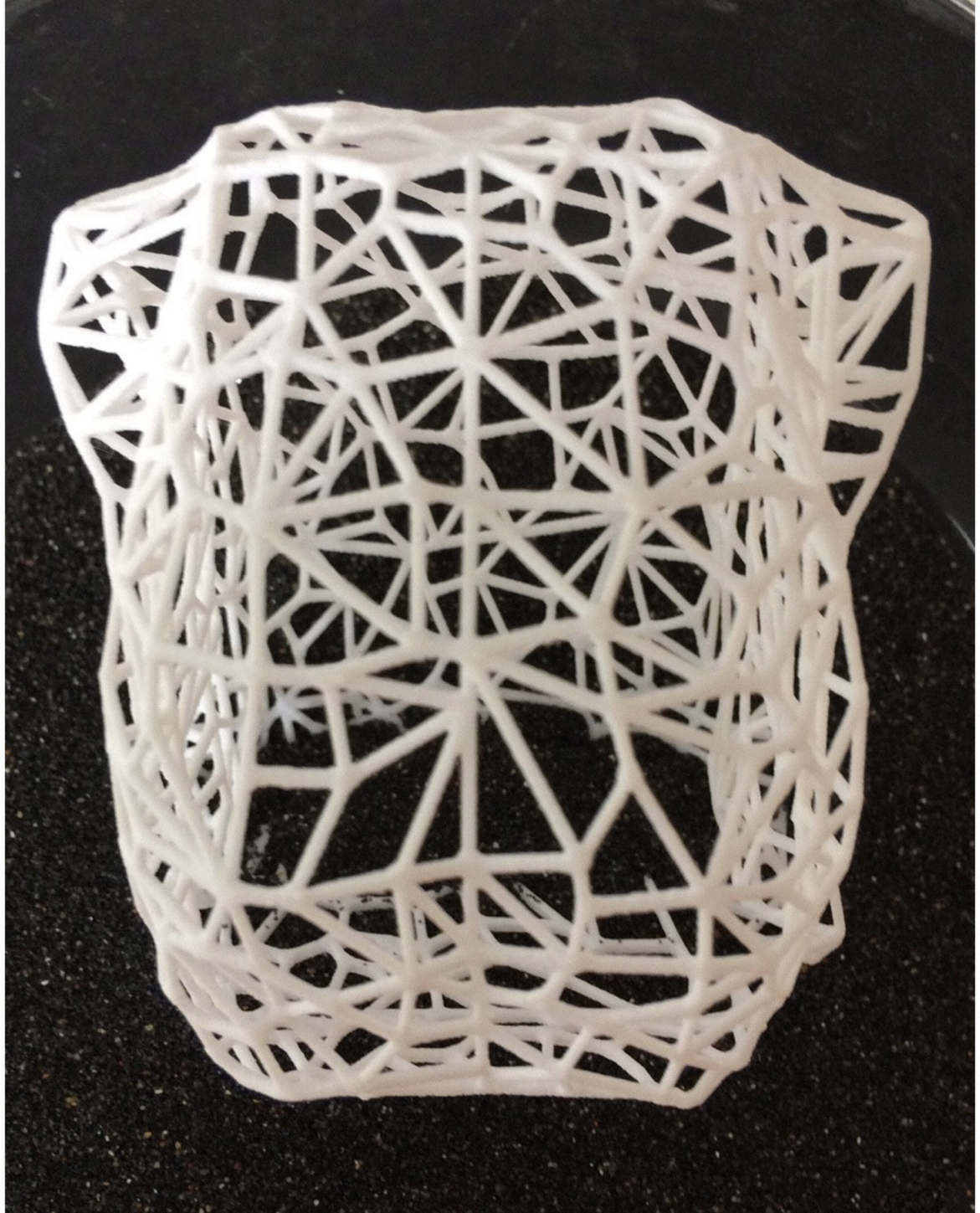


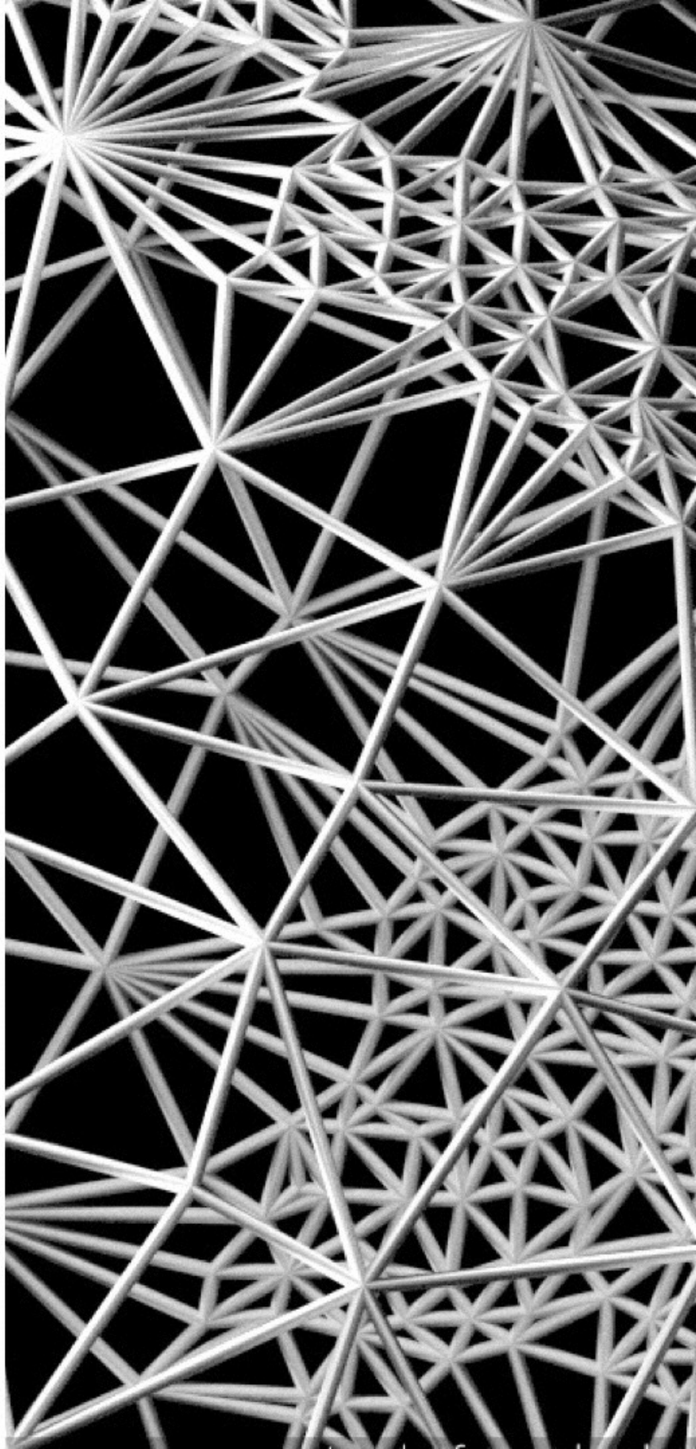
We also practiced with bacteria known for their probiotic properties (*Lactobacillus plantarum*), which are able to strenghten the bees and give them a sense of wellbeing that is reflected in their microbiome.

When the bees land upon the skin of the Intelligent Beehive, the pollution particles that stick to the hairs on the bees' body come in contact with the bacteria living in the biofilm on the outer skin of the hive.

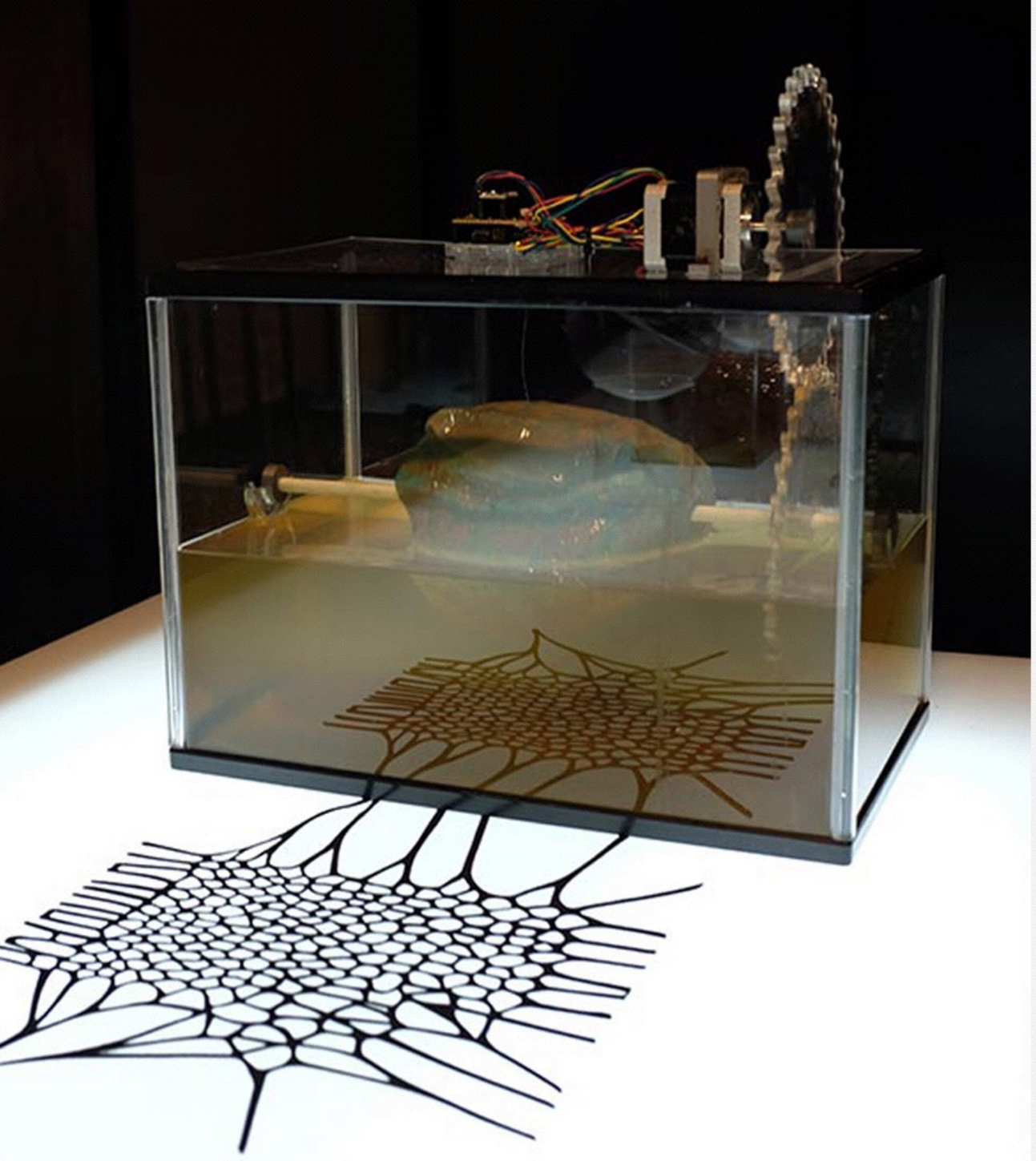


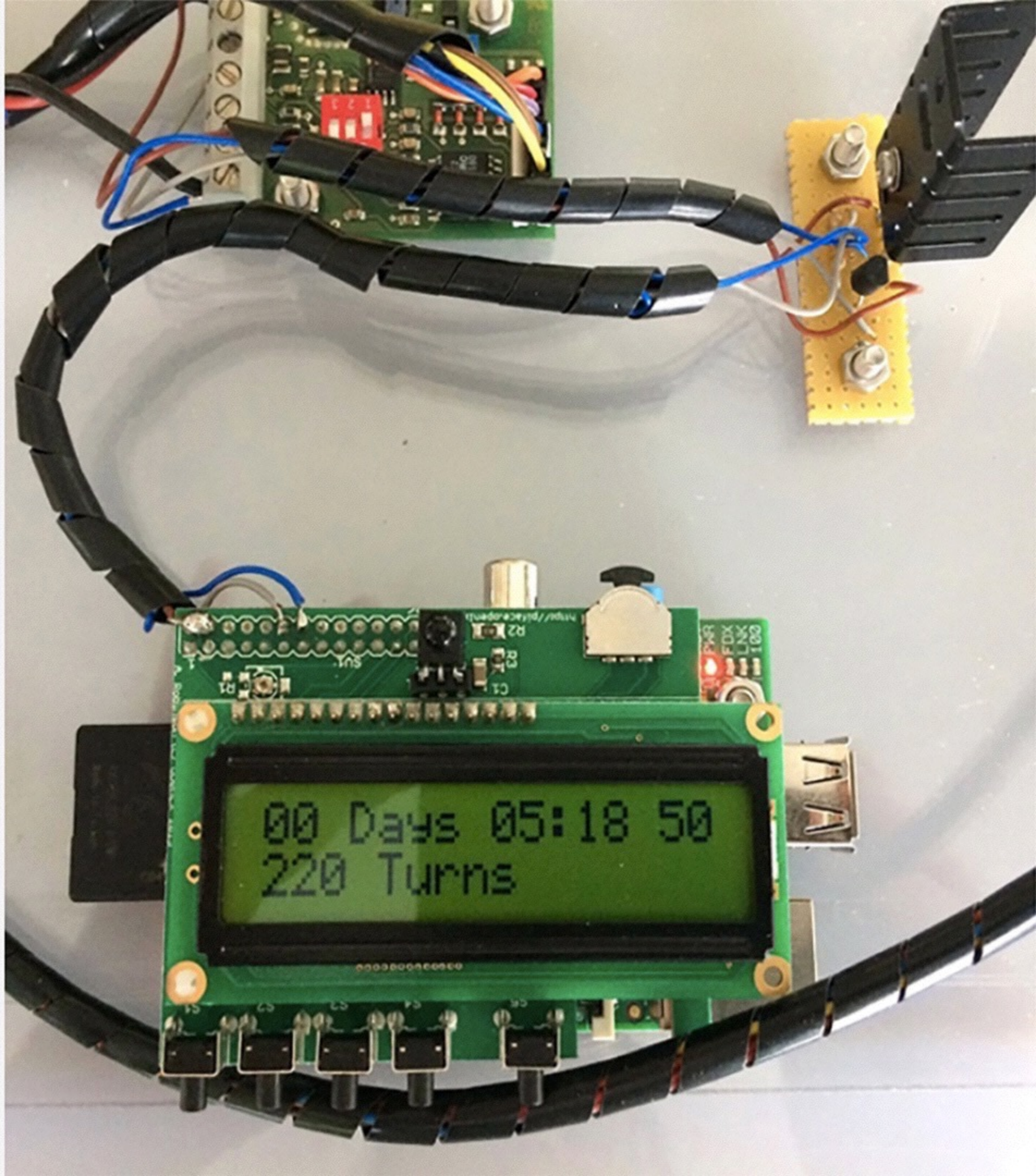
The ongoing development of these bacterial colonies on the cellulose membrane forms a crust that crumbles under ever new layers of bacteria.
This make that the Intelligent Beehive’s outer membrane becomes protected by a layer of living cells that constantly feed off the dead ones and thus cleans and repairs itself.





Another goal of the project was to research the possibility of 3D-printing with chitine, a component that can be found in the exoskeletons of invertebrates and thus also in dead bees.
The 3D printed beehive-skeleton would then be wrapped with a cellulose skin and topped with the biofilm populated by bacteria.
The printing whith Chitine/Chitosan turned out to be very complex. It is a complicated multifaceted biotechnical-project and primary results are promising, but further development needed serious financial investment.

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Instead we decided to focus on growing stronger microbial skins and make them waterresistant in combination with a layer of Chitosan.
We carried out some experiments in growing microbial skin immediately round a small 3D- printed model of the beehive.
This was done in several setups: with magnetic stirrers and stepper motors to assure a steady turnover of the object in the growth medium.

SENSORIAL SKIN FOR AN INTELLIGENT GUERILLA BEEHIVE

was realized in collaboration with the Urban Bee Lab (Brussels), okno (Brussels), the Vrije Universiteit Brussels, the Bio HackLab (Barcelona), FabTextiles (Barcelona), the Green FabLab (Barcelona).

annemarie@annemariemaes.net
http://annemariemaes.net