

vascularization

*research at the intersection
of design, experimental surgery,
and nuclear physics*

Emile De Visscher – January 15, 2025

• *alchemy* • *bio-inspired* • *design for the living* • *electrical treeing* • *experimental surgery* • *fulgurites* • *new materials* • *particle physics*
• *practice-based research* • *research through design* • *surgery*

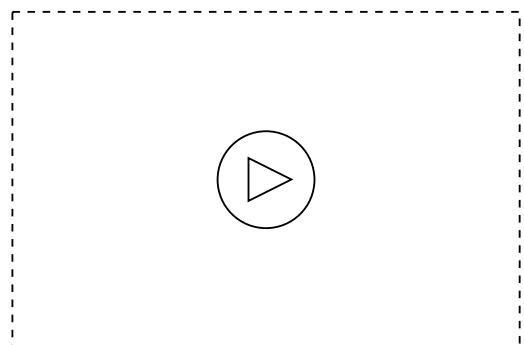
A recent paradigm shift in materials science and engineering has taken place. The conventional emphasis on strength, durability, and stability generates objects that are difficult to recycle and therefore directly linked to the current ecological crisis. Consequently, researchers in design, engineering, and architecture are now turning their attention to the evolutionary, self-healing, multifunctional, and active capacities of materials that behave just like living organisms. However, in living organisms, these mechanisms are often guided and orchestrated by dendritic or vascular typologies, which support metabolic functions, based on fluid circulation, and the optimization of interactions with the environment.

The resulting project stems from a collaboration between designers, biologists, and surgical researchers aimed at understanding the functioning of vascular structures in organs, and to find new techniques for manufacturing dendritic structures. In the medical field, this research focuses on extracellular matrices (ECMs), the architecture of our organs in which cells can operate. The efficient manufacture of these ECMs is a key challenge for surgical research as a means of mitigating the lack of organ donations.

Inspired by fulgurites, vitreous material formed by lightning striking sand or sediment, we have succeeded in using electrons to tunnel through materials at the micrometric scale. To accomplish this, we required an electron accelerator, which we were able to use at the École Polytechnique in Palaiseau on several occasions. The principle is simple: a block of PMMA (transparent, commonly known as plexiglass) or PLA (bioplastic, green-yellow in color) material to a beam of electrons that are captured in its structure, then given an exit path by a shock from a nail connected to the terrestrial network. Instantaneously, all the electrons are released, forming vascular networks whose pathways are optimized by the process itself. This project, both an investigation into material expression and the development of potential applications, challenges the role of the designer as a mediator between knowledge, technologies, and the discourses of disciplines traditionally considered incommensurable.

This contribution was published on www.able-journal.org in a video.able format:

www.able-journal.org/en/vascularization





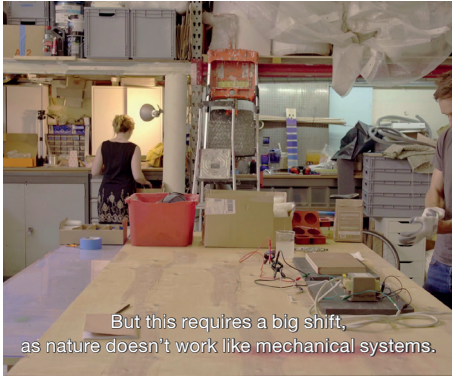
How to design for the living?



Many designers want to stop supporting the logic of industrial pollution.



They are turning towards biology, to grow things rather than extract them from the ground.



But this requires a big shift, as nature doesn't work like mechanical systems.



Instead of using stable materials, simple geometries, and energy-intensive processes,



designers have to work with active materials, complex geometries and efficient self-generating phenomena.



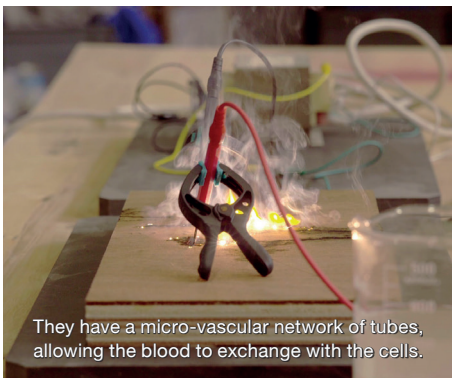
The project started by teaming up with surgeons - the people who are probably the most involved



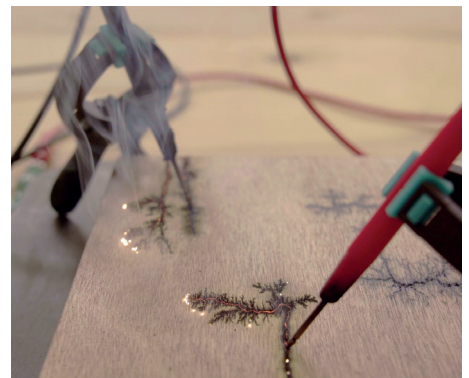
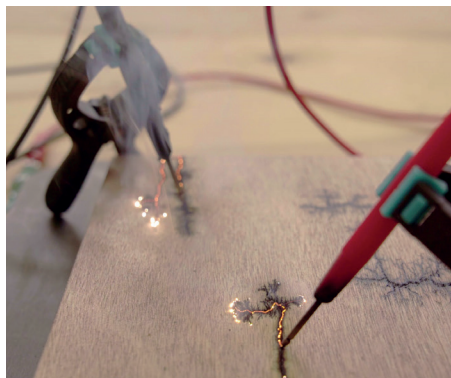
in keeping things alive. They were looking at ways to efficiently

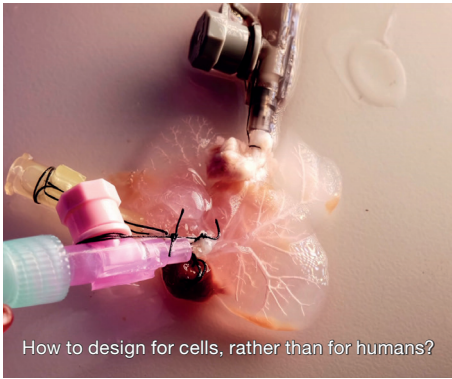


fabricate Extracellular Matrices, the architecture of organs, to palliate donation scarcity.



They have a micro-vascular network of tubes, allowing the blood to exchange with the cells.





How to design for cells, rather than for humans?



Vascular structures are found all over the biological kingdom, both macro and micro-scales.



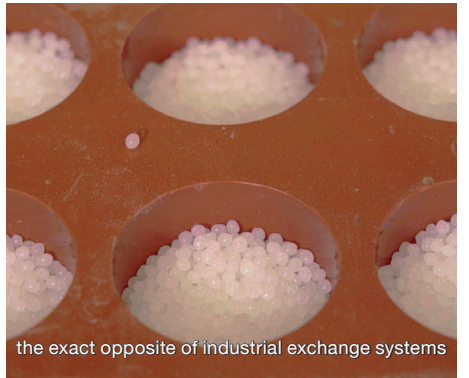
It is one of those geometries which belongs to nature.



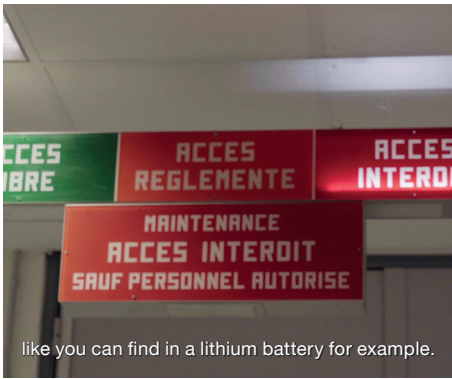
a distribution system optimizing surface-contacts and liquid exchanges.



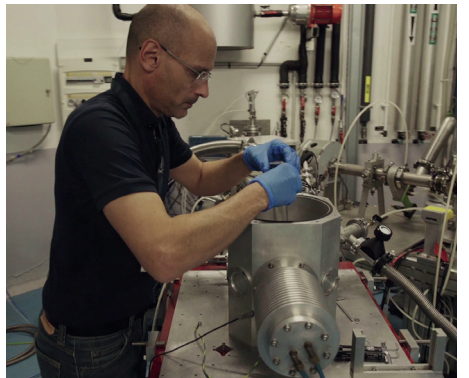
It is a complex geometry, but with simple materials

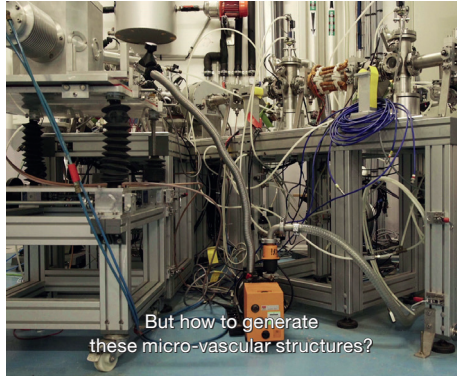
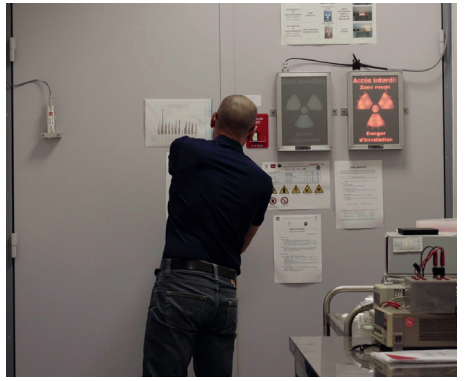


the exact opposite of industrial exchange systems

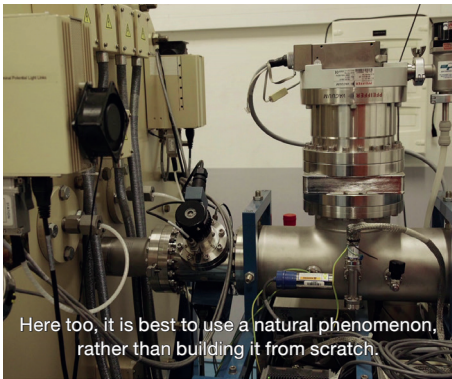


like you can find in a lithium battery for example.





But how to generate these micro-vascular structures?



Here too, it is best to use a natural phenomenon, rather than building it from scratch.



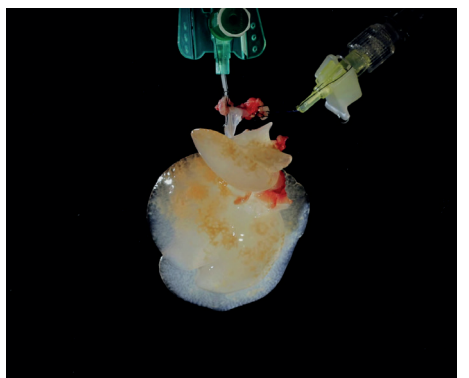
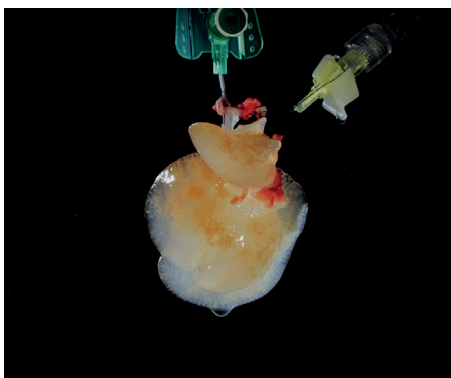
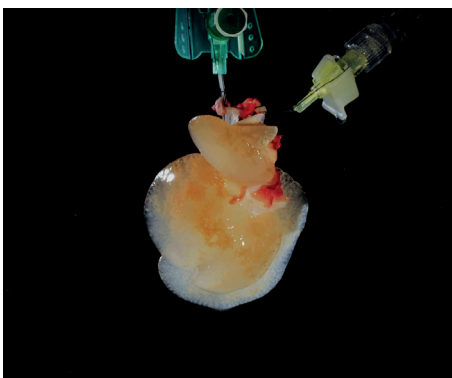
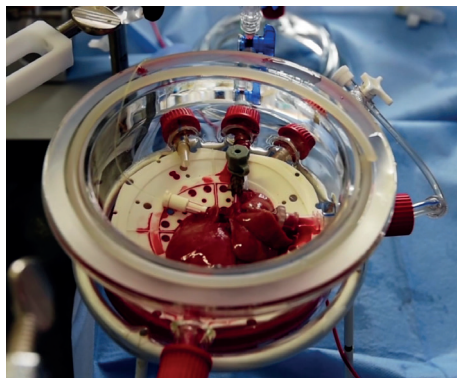
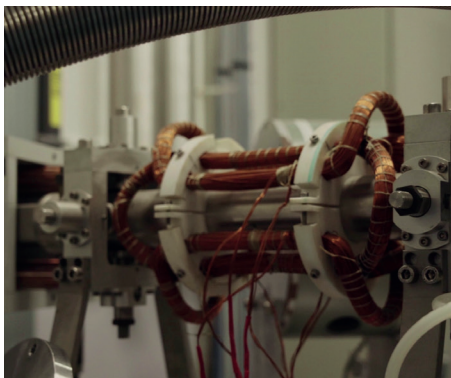
Self-generating vasculature can be found in lightning storms.

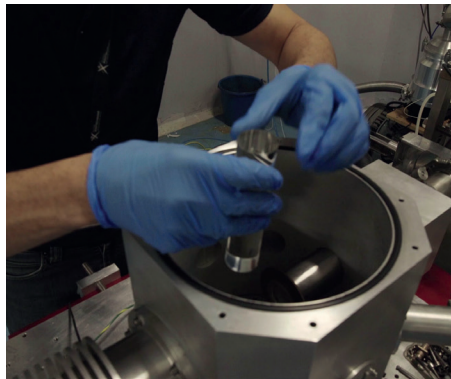
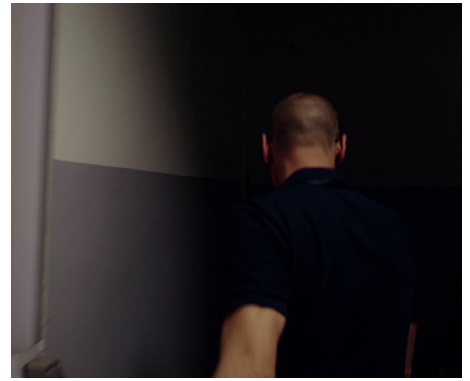
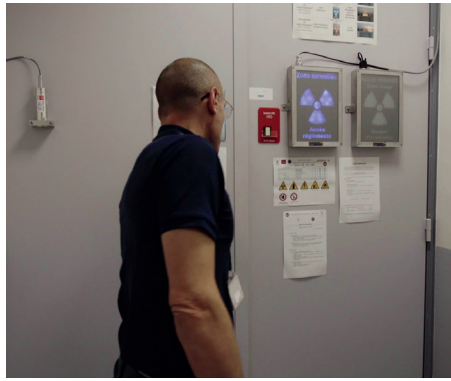
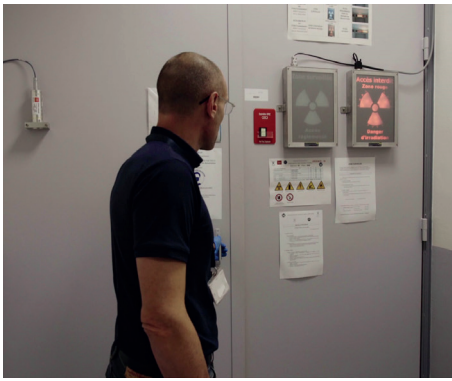


We explored a way to replicate mini-lightning in biomaterials.

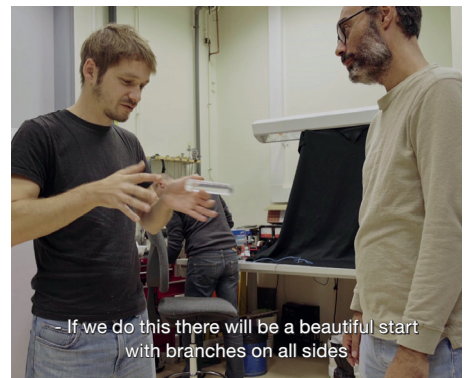


to carve self-optimized vascular structures.





- Irradiate like this and hit here, or irradiate like this and hit there.



- If we do this there will be a beautiful start with branches on all sides.

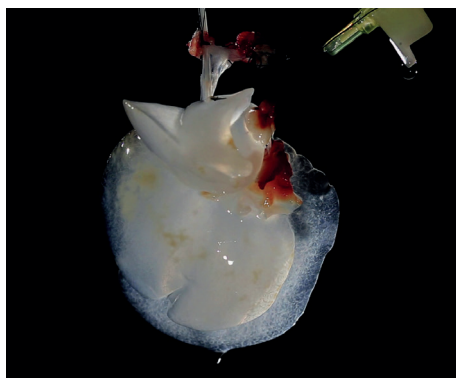
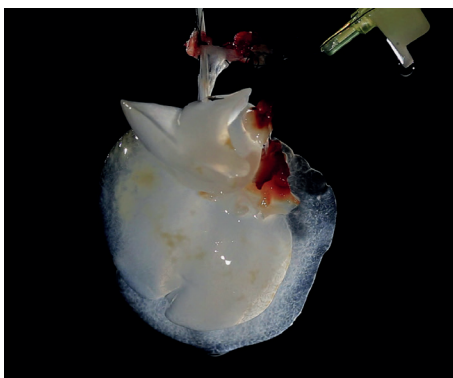
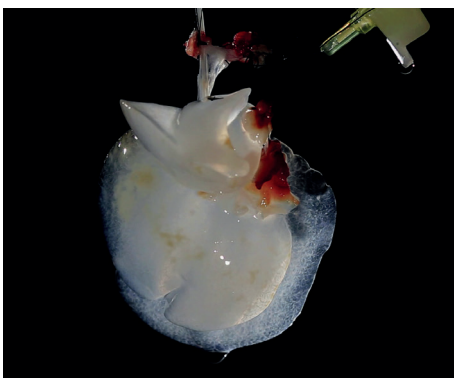
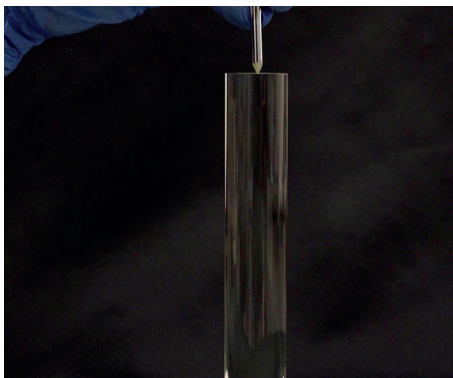
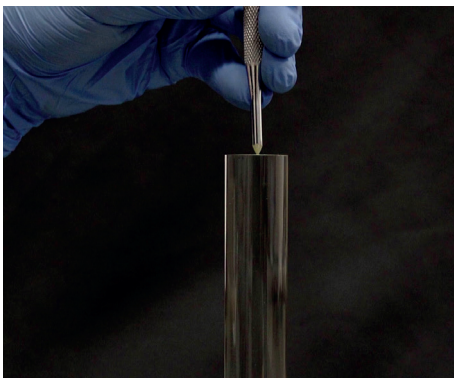
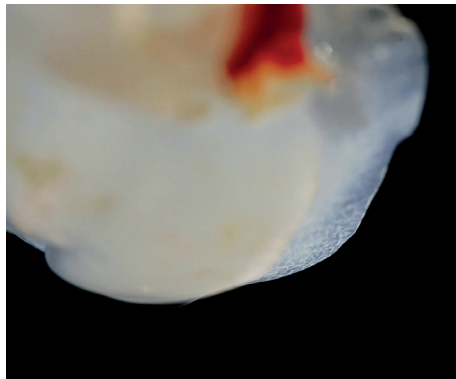
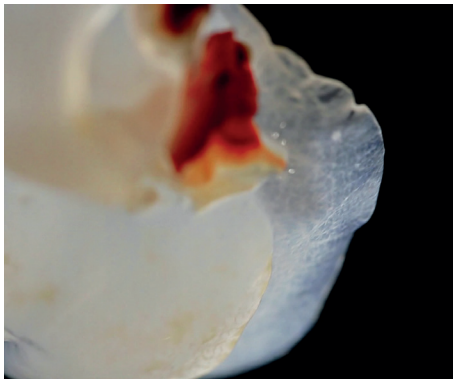
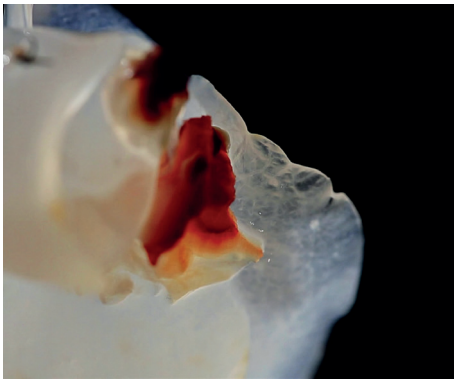
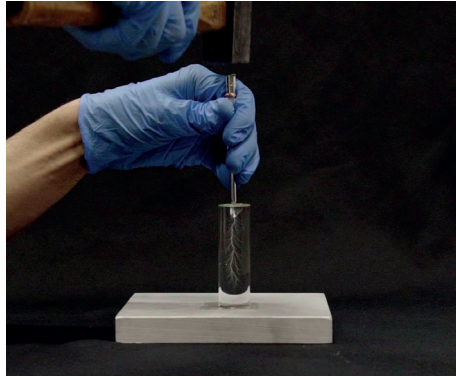
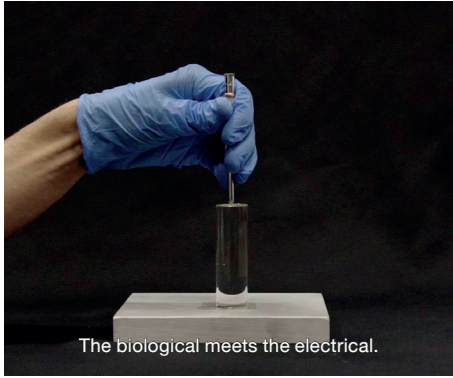
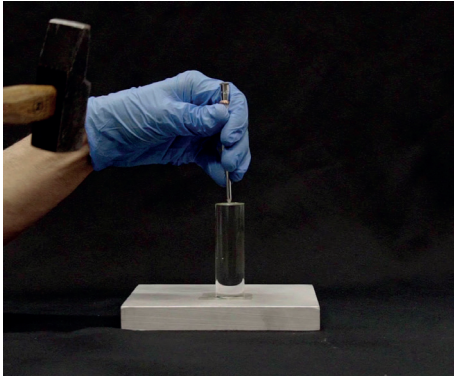
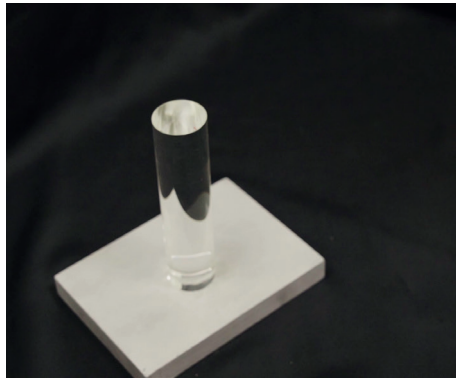
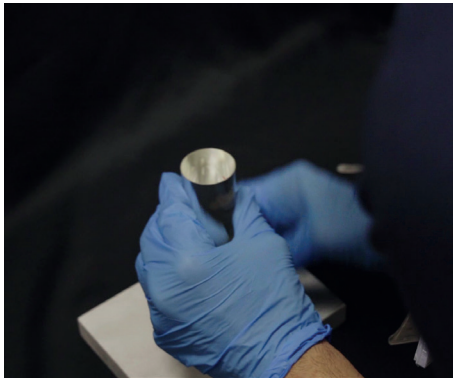


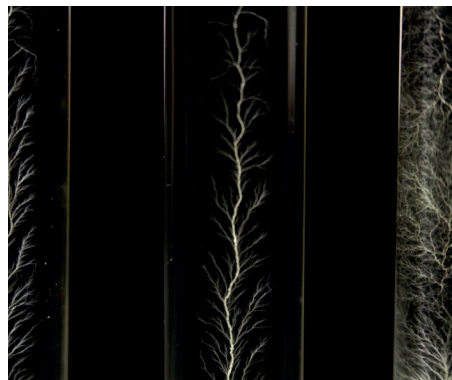
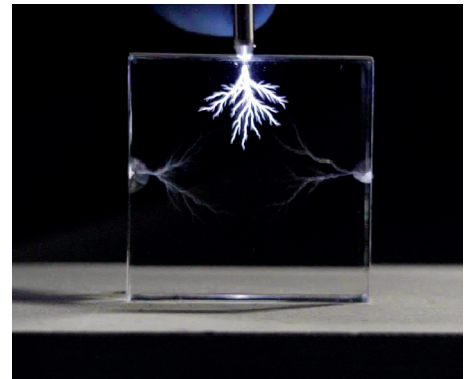
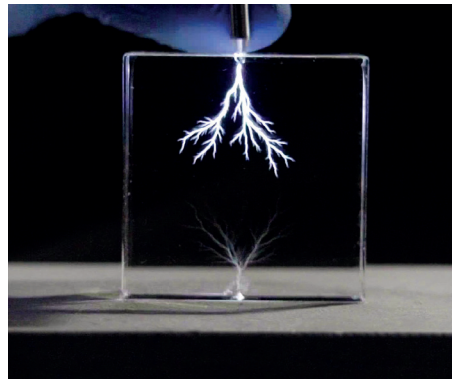
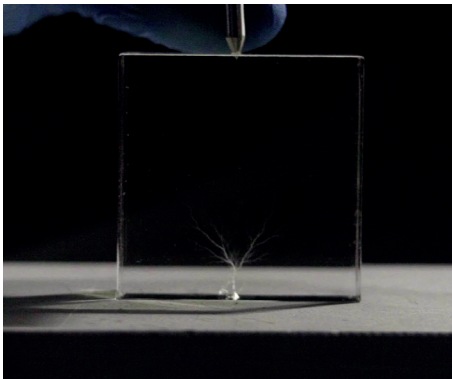
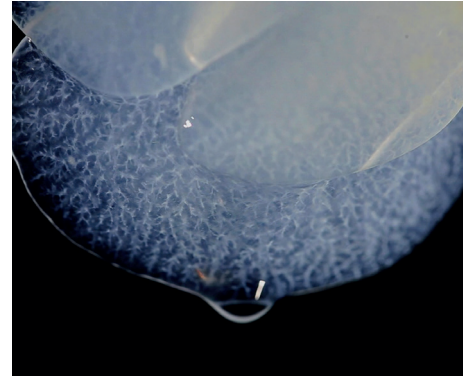
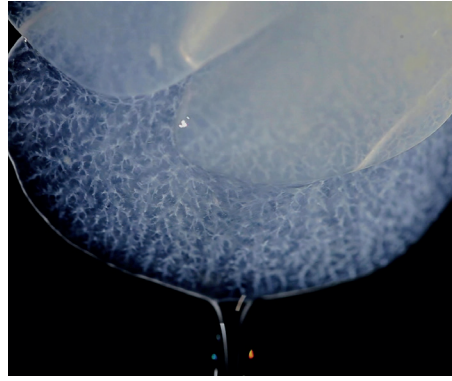
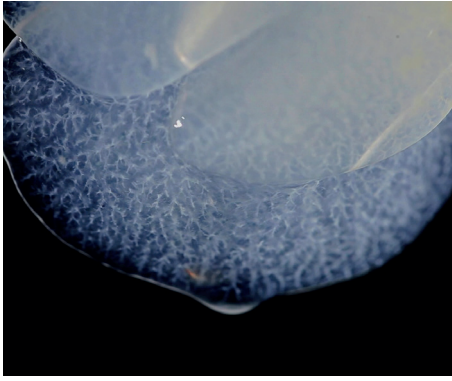
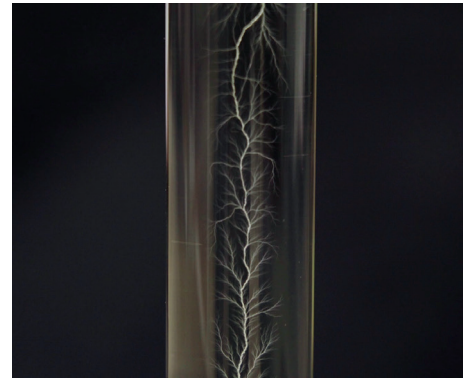
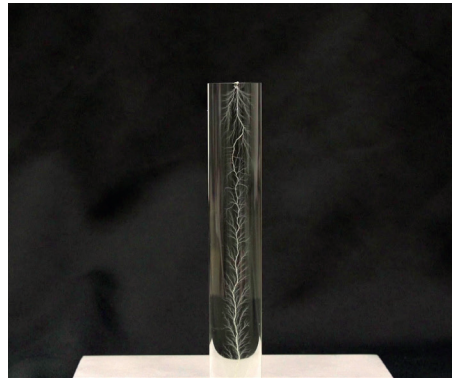
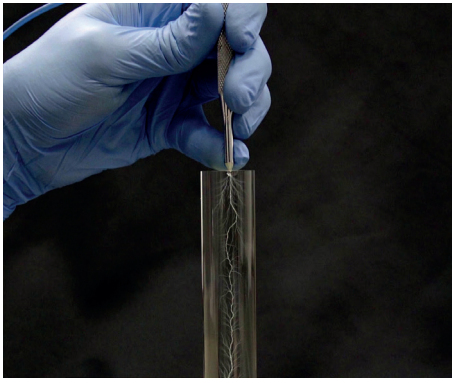
A natural phenomenon is used to produce an architecture



to support another natural phenomenon.







credits

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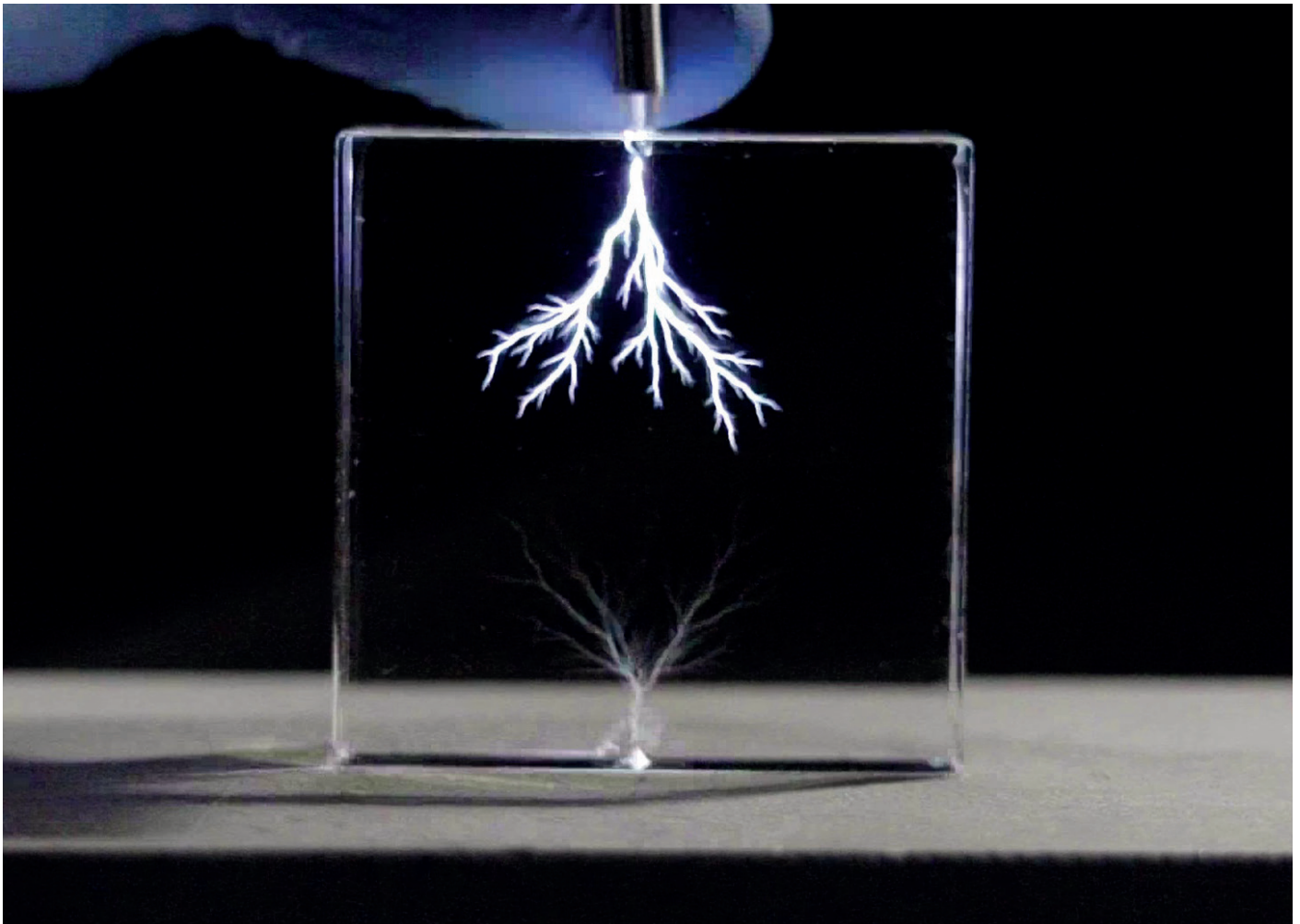
director, camera and editing: Boris De Visscher

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voice-over: Sophie Cazimi

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Emile De Visscher (PhD) is a design researcher and engineer. He completed a PhD at PSL University (ENSAD, SACRe program) and a postdoc at Matters of Activity EXC (Humboldt Universität). He now holds a Junior Professorship at ENS Paris-Saclay and the Design for Ecological Transitions Chair at CRD (Centre de Recherche en Design). His work focuses on the invention of new production tools and materials, in order to question our social, political, and ecological futures.

<https://devisscher.com>

<https://matters-of-activity.de/en>

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SCIENTIFIC AND CONCEPTUAL CHALLENGES OF THE PROJECT

De Visscher, Emile. 2024. "Biocompatible radiations – Designing for the living." In *Toward a New Culture of the Material*. Edited by Frank Bauer, Yoonha Kim, Sabine Marienberg, and Wolfgang Schäffner. Berlin: De Gruyter, <https://doi.org/10.1515/9783110714883>

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