Algae Microculture System

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Background

Algae cultures is reported to offer the highest possible growth rates of biomass, and the study of algae for use in production of biofuels, bio mass and neutraceuticals is of great interest for sustainable engineering of production methods.
This project develops a micro fluidic system, in which algae can be trapped in microchambers for study of growth rate and behavior under a variety of culture conditions. The system comprises multiple identical chambers, valve systems with a membrane as lock mechanism for injecting and harvesting algae from the chambers, and filter systems that will provide a fresh supply culture growth medium to the algae. The filter prevents the algae from escaping the chip with the medium flow.
Here our focus is on the filter system, the valve system and testing the chambers on live algae.

Methods

In the development of the valve system two kind of valves is used: A normally open valve and a normally closed valve each operated by adjusting pressure on a control channel blocked by a membrane pressing down in the channel to be open or closed. The normally open valve is open at ambient pressure, while the normally closed valve is closed.
For both valves, the strength and stability of the membrane is studied. The membrane deflection and thickness as a function of the applied pressure in the normally open valve is studied as well.
In the research of the filter system, a hydrophilic filter and a hydrophobic filter is tested. Different methods of isolating the filter to each chamber-filter-valve systems are also tested.
Finally we have tested algae culturing in the system.

Results

When the membrane deflection increases, the membrane thickness decreases due to tensile stress.
The membrane stability tests reveal, that an applied pressure from a fixed volume container decreases exponentially with time to a certain pressure above ambient pressure.
There is a linear relation between the pressure where the growth medium start to leak through the valve system and the pressure of the membrane control channel.
The hydrophilic filter and the hydrophobic filter both absorbs liquid and can cause diffusive mixing of liquids between chambers. This is avoided by making a PDMS-stamping process that fills certain regions of the filter with a PDMS-polymer blocking any diffusion of liquids.
We also report on our tests to see whether algae can be reliably trapped by the system

Conclusion

Although the valve system still have some issues and need optimization, it is still possible to make a functional valve system. Using the PDMS-stamp method, it is possible to make a fine functional filter system.