Development of novel silica hydrogels for the production of extracellular compounds with encapsulated diatoms

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In marine microalgae research slow cell growth, costly downstream processing and low benefits have so far hindered the implementation of production processes[1]. Studies have shown that immobilisation in hydrogels can enhance algal growth rates and allow continuous production of extracellular compounds[2]. In marine systems, silica hydrogels are advantageous over the conventional matrix calcium alginate due to their improved physicochemical stability in presence of chelating agents and cations[3].

This doctoral research within the BMBF project COMBINE aims to develop novel silica hydrogels for marine diatoms with improved structure properties to achieve higher growth rates and biomass loading. Preliminary results show that diatom growth was reduced by 60 % in silica hydrogels as compared to calcium alginate. Light limitations were excluded since the inorganic gels show nearly 60 % less wavelength absorption in the PAR region than the organic ones. A decrease of the silica concentration by the factors 2 and 4 increased the growth by 33 % and 78 %, indicating a correlation between the gel density and the cell division capacity. We observed a size reduction of highly loaded hydrogels by almost 50 % and subsequent 4-fold increased cell leakage, possibly due to breakage of the brittle gel from the pressure of dividing cells. A reduction of the particle volume by the factors 10, 40 and 80 increased cell growth approximately 3-, 10- and 20-fold and a growth gradient towards the center of the matrix was observed, revealing volume-specific diffusion limitations.

We will present our recent findings together with a comparison of novel silica hydrogels from various mixtures of functional silica precursors investigated towards gel structure, diffusion capacities and cell growth to overcome current limitations and shed more light into immobilisation materials facilitating the profitable production of high-value extracellular marine algal products.

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