Session: Biofilm application

The impact of light regimes on Chlorella vulgaris biofilm structural dynamics and physiology

Yan Gao[1], Olivier Bernhard[2], Patrick Perre[1], Andrea Fanesi[1], Filipa Lopes[1]

[1]*CentraleSupélec - Université Paris-Saclay / LGPM, France*

[2]*Inria / Biocore, France*

Biofilm-based microalgae technologies are attracting more and more attention for their potential to improve sustainability and cost-effectiveness compared with suspended-cells systems. Mixing is then replaced by a mechanism to rotate the biofilm so that cells have periodically access to light, and high light intensities are diluted in time, thus avoiding photoinhibition. Though alternating light regimes (L/D cycles; L-Light, D-Darkness) are known to enhance photosynthesis and therefore biomass productivity in suspended cultures, few works have been carried out to evaluate their effect on biofilm-based systems. It becomes then key to understand the impact of the light/dark regimes on the growth and structure of microalgal biofilm to optimize the bioprocess. Here, we study the dynamics and physiology of Chlorella vulgaris biofilms in a flow-cell exposed to various lighting conditions. The effect of light cycle duration (T) lasting from 15 s to 3 min at constant average light (100 µmol·m-2·s-1) were compared with the equivalent continuous light. Within L/D regimes examined, the highest specific growth rate (0.31 d-1) was obtained with the shortest light period (5 s). By contrast, growth penalties were observed with extended light exposure times of 30 s and 1 min. The maximum photochemical yield data was also consistent with the growth performances. In addition, biofilms present thicker and smoother 3D structures over time in general. Cell size responded impressively to the peak light intensity, as well as chlorophyll-a content (pg·cell-1). Within light regimes investigated in this research, we conclude that the photoinhibition effect on growth can be avoided by applying a short cycle time of 15 s under intense light. Meanwhile, a modeling tool based on experimental data is currently being developed. This will provide a better understanding of the effect of light intensity, duration, and duty cycle on biofilm growth. It will also help identifying light regimes that will improve light utilization efficiency and thus biofilm productivity.

Keywords: Microalgae, biofilm, structure, light regime, growth rate, productivity.