Linking biofilm spatial structure to real-time microscopic oxygen decay imaging

S. Rubol1, A. Freixa2, X. Sanchez-Vila3 and A. M. Romani4
1Department of Energy Resources Engineering, Stanford University, Stanford, CA, USA
2Catalan Institute for Water Research (ICRA), Girona, Spain
3Hydrogeology Group, Department of Civil and Environmental Engineering, Universitat Politècnica de Catalunya, UPC, Barcelona, Spain
4Institute of Aquatic Ecology, University of Girona, Girona, Spain

Abstract:

Two non-destructive techniques, confocal laser scanning microscopy (CLSM) and planar optode (VisiSens imaging), were combined to relate the fine-scale spatial structure of biofilm components to real-time images of oxygen decay in aquatic biofilms. Both techniques were applied to biofilms grown for seven days at contrasting light and temperature (10/20 °C) conditions. The geo-statistical analyses of CLSM images indicated that biofilm structures consisted of small (~10^0 µm) and middle-sized (~10^1 µm) irregular aggregates. Cyanobacteria and EPS (extracellular polymeric substances) showed larger aggregate sizes in dark grown biofilms while, for algae, aggregates were larger in light-20 °C conditions. Light-20 °C biofilms were most dense while 10 °C biofilms showed a sparser structure and lower respiration rates. There was a positive relationship between the number of pixels occupied and the oxygen decay rate. The combination of optodes and CLMS, taking advantage of geo-statistics, is a promising way to relate biofilm architecture and metabolism at the micrometric scale.

Keywords: confocal laser scanning microscopy, real-time images of oxygen concentration, biofilm growth, planar optodes, biofilm respiration, geostatistics