On the use of oxygenic photosynthesis for the sustainable production of commodity chemicals

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A future, sustainable, society will have to largely refrain from the use of fossil carbon deposits. In such a society, electricity can be made from various renewable sources as the primary source of energy. However, in this scenario also for the synthesis of carbon-based materials, from bulk chemicals, an alternative for the fossil resources is required. A sustainable approach towards this, is the synthesis of commodity chemicals from CO_2, water and sunlight.

Multiple, parallel, paths to achieve this have been designed and tested, in the science domain of chemistry as well in that of biology. In the latter domain the use of both chemotrophic and phototrophic organisms has been advocated. I consider it likely that de 'direct conversion' of CO_2 and H_2O, catalyzed by an oxyphototroph (most likely a cyanobacterium), will turn out to become the most economically relevant of these transformations. This is because of the very efficient oxygenic photosynthesis in cyanobacteria and the relative ease of scale-up of this process, which does not involve any other macroscopic interface than the introduction of photons into a bio-reactor.

In the optimization of a cyanobacterial production organism ('bio-solar cell factory') several aspects have to be addressed, like: (i) Optimizing the (carbon) flux to the desired product; (ii) Increasing the genetic stability of the producing organism, and (iii) Maximizing its energy conversion efficiency. Significant advances have been made on all these three aspects during the past few years and these will be discussed: (i) Increasing the carbon partitioning to > 50 %; (ii) Aligning product formation with the growth of the cells and (iii) Optimization of the thylakoid composition and expansion of the PAR region for oxygenic photosynthesis.