Light system for aquatic photosynthetic organisms

Abstract

The present invention relates to a light system for aquatic photosynthetic organisms comprising at least one panel equipped with RGB diodes (LEDs) and characterised by the fact that each diode provides three colours (blue, red and green) which can be independently modulated to obtain a wide range of colours (from monochromatic to white) in the visible spectrum and whose light intensity is independently modulated between 0 and 600 µmol. photons.m^{-2}.s^{-1} for each colour (Fig 1). It can therefore mimic the light present in all marine environments (surface, sea bottom, etc.) in any season and the light that planktonic microorganisms may encounter - in terms of intensity and colour - during their movements in the water column.

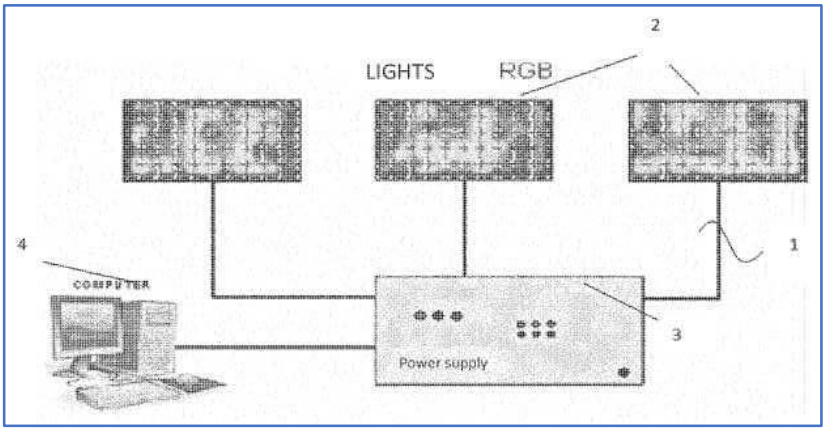

FIGURA 1 – Graphic scheme with light system (1), at least one panel having a plurality of indipendent sensors said LEDs (2), electronic device (3) connected to said at least one panel, and a computer (4)

State of the art

Light is one of the most important ecological parameters for the growth of plant organisms as it triggers the photosynthetic process that transforms light energy into biochemical energy. The reproduction of natural marine light is a crucial point in the experimentation and growth of microalgae. The intensity and light spectrum of the light vary over time on a seasonal scale, during the same day and with the change in depth. Reproducing natural marine light has scientific limitations - the knowledge of the optical properties of marine waters - and technological limitations - the different aspects of light penetration in the water column must be taken into account.

Invention description

The features of the invention allow the system to reproduce any type of marine light absorbed (in the case of algae, plants) or received by marine organisms (in the case of animals) living at different depths or moving along the vertical, or in different seasons or different seas (Fig. 2). The invention is based on diode lighting (LEDs), which have the following advantages: (i) they create little heat (so do not require a specific cooling system); (ii) they can be easily and precisely modulated in intensity; (iii) they are RGB, i.e. each of them has three colours that can be modulated separately. This creates a perfect homogenisation of the spectral light over the entire illuminated surface. In addition, each diode, by mixing the three colours, reproduces all shades of white (from cold to warm), depending on the contribution of the red/blue/green spectrum (Fig. 3).

Industrial Property

European Patent Application No. 2883950 filed with priority on 12/12/2013, validated and granted in Italy and in The Netherlands

Applicant

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TTO (Technology Transfer Office):

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Advantages

The patented technology:

- speeds up and increases the biomass production yield (i.e. with 10 l of culture, it accelerates the production of algal biomass by a ratio of about 4 to 1 compared to ordinary lighting).
- is adjustable (in terms of quantity, colour and light intensity) and maximises the ability of the algal biomass to capture light. This aids typification - because it allows to condition the production of certain compounds (e.g. lipids, carotenoids, carbohydrates, antioxidants, etc.) from the algal biomass - and avoids light stress in photosynthetic organisms;
- is space-saving, can be integrated into large-scale systems (i.e. photobioreactors) and is inexpensive (the cost of a 40x20 system is about €2000 but, in a larger system, the cost would increase slightly because the electronics are the same as in a smaller system);
- allows an acceleration in the production of micro-algal biomass (i.e. it has been estimated that, compared to some fluorescent tubes, the system allows a multiplication of about 2 or 3 times the algal production);
- enables the optimal maintenance of all light-sensitive marine organisms.

Applications

The invention finds application in the following areas:

- Photobioreactor Manifacturing – because the invention is a very flexible system and produces little heat;
- Scientfic Research – for the production and usage of algal biomass in the research;
- Nutraceutical, Cosmetic, Cosmeceutical markets - as it allows the acceleration of the production of molecules from algal biomass;
- Aquariology - for any type of aquarium (family or industrial), to create simple slighting effects and for maintenance of light-sensitive aquatic organisms (e.g. coral, etc.).

Development stage

Current TRL: 4-5

The system is currently used in the laboratory for scientific experiments on micro-algae and small fish (size of illuminated tanks: 5 litres; size of each light system (bxh): 40 cm x 20 cm).

Perspective TRL: 6

A larger light system (1 m long) will be finalised for a new generation photobioreactor incorporating the lighting system as patented is being planned.

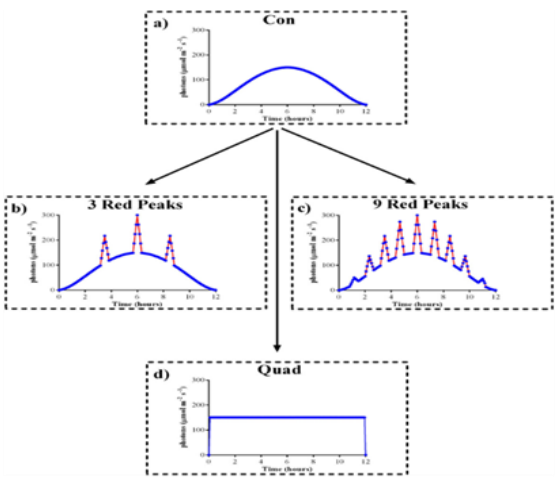

FIGURE 2 – Examples of light distribution over 12 hours The three colours can vary independently, reproducing all kinds of intra-marine variability (intensity and spectral)

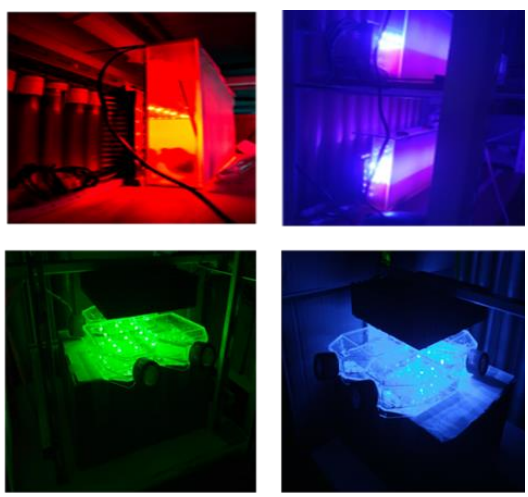

FIGURE 3 – Examples of light colours obtained with the light system

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