Organic light emitting diodes and nanoparticles for controlling the some behaviours of living organisms

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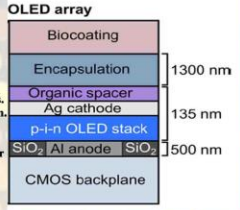
Abstact:

1-We need to control behavior of cells and organisms by manipulating in action potential .This work can be used in treatment of diseases and behavioral study.
2- Light is a method that can change action potential.
3-Light source have some difficulties such as inflexibility, low penetration depth and non-biocompatibility.
4- these problems can be solved using organic (OLED) suggest to solving these problems.
5-OLEDs have organic molecules in their semiconductor layer.
6-OLEDs can divergent the light without lens therefore the light can penetrate deeply and organic layer produces flexibility and biocompatiblity.
7-Nano particles also can localize the light and change the light to the heat and therefor alter the action potential in cell membrane and modify behavior of cell and organisms.

Introduction:
Action potential is a transient and rapid events in cell membrane potential. Light can open and close the ionic channels and then alter the action potential and cells, function. One of the light source is organic light emitting diode (OLED).

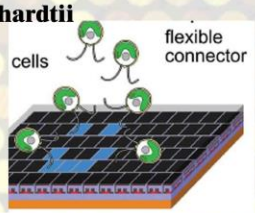
1-OLED microarrays

Organic light-emitting diodes (OLEDs) are organic emissive and conductive semiconductor layers which have electroluminescent emission. OLEDs have some advantages that made them very useful for optogenetics. They have very short response times (μ s or sub-μs) and high temporal resolution. However, they are flexible, this property made them implantable for optical-neural interfaces. OLEDs have high efficiency and less heat production. They emit light at wide spectral band then they are tunable.
These characteristics made theme suitable to proper a microarray for biophotonic applications

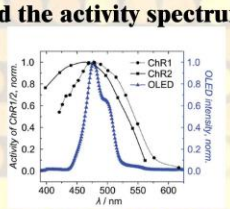


2-Inducing effect of light on the green alga Chlamydomonas reinhardtii

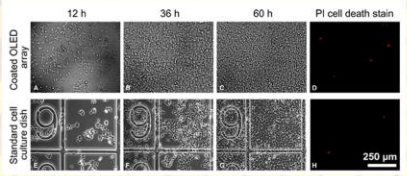
Green alga (Chlamydomonas reinhardtii) have Channelrhodopsin 1 and 2 (ChR1/2), that are sensitive to light.
Alga move toward the OLED.
Then, Generated light by OLED is suitable for algae movement.



3-Emission spectrum of OLED and the activity spectrum of ChRs.



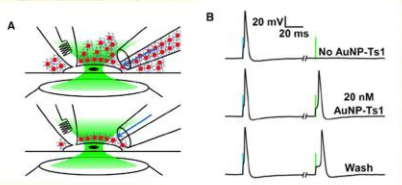
4-OLED have not cytotoxic effects on living organisms.



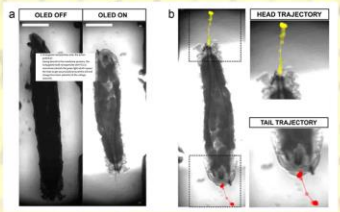
Embryonic kidney cells proliferate on OLED and PI staining did not show significant cell death.

7-Conjugated nanoparticles alter the action potential:

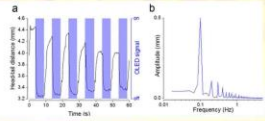
Having bound to the membrane proteins, the Conjugated Gold nanoparticles with TS1 (a neurotoxin) absorb the green light which causes the heat to get accumulated around the cell and change the action potential of the voltage channels.



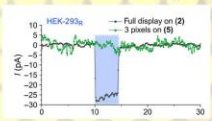
6-Imaging and analysis of Drosophila larval behavior



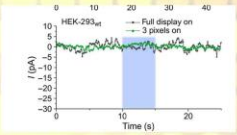
OLED was placed below the larvae and turn on – off for 5 seconds priodically. Head and tail trajectory was observed and measured.



5- OLED-induced change in current for multiple cells



HEK-293R cells have ChR in their cell membrane . OLED turn on below the cells. The produced current was negative that show the action potential modified.



HEK-293wt cells have not ChR . OLED turn on below the cells. The current did not change that show no change in action potential.

8-Discussion:

OLEDs are flexible and have thin layer due to having organic semiconductor layer and carbon binds.
Organic semiconductor layer increases the holes and OLED efficiency.
Having bound to the membrane proteins, the Conjugated Gold nanoparticles absorb the green light which causes the heat to get accumulated around the cell and change the action potential of the voltage channels.

9-Conclusion

OLEDs:
-increase the effect of optical stimulations.
-are compatible with the cells and organisms.
The nanoparticles alter the cells and organisms' behaviours because of having localized the heat around the cells.

Reference

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