BIOORGANIC SEMICONDUCTORS FOR SUSTAINABLE OPTOELECTRONIC DEVICES AND BIO-INTEGRATION

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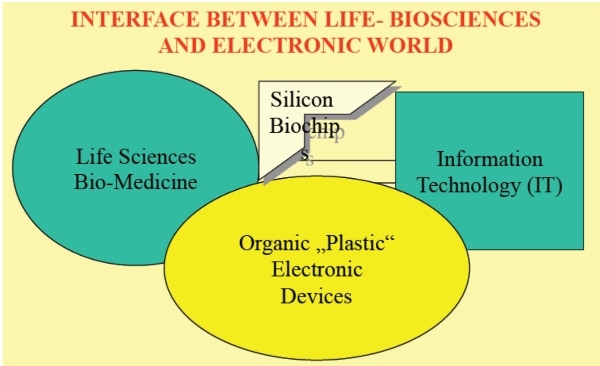
Bio-organic electronics is emerging rapidly in the scientific literature.



Generally, bioelectronics has been a dream of cybernetics for quite some time. The pioneering work of Peter Fromherz (Max Planck Institute for Biochemistry) interfacing the neurons with silicon circuits go back several decades. However, the bioelectronics has been limited to silicon based electronic circuits for quite some time. Recently, the discovery of organic semiconductor devices has opened up a new avenue to realize this dream of biological interfacing with electronic circuits.
Organic semiconductors, especially bio-organic, bio-compatible semiconductors display a list of properties which are important for the interfacing of biological systems with electronic world: Their biocompatibility, non toxicity, processability and operational stability in aqueous media are often much better than the inorganic counterparts.

To make an interface with biosystems, the transformation of the electrical information into ionic and protonic information is necessary. Biosystems are often based on ionic transport and signal transduction based on electrochemical systems as opposed to electronic world which use normally the electronic conduction based on solid state physics. In such transformation of the signal from electronic world to the bio-world, we need materials and systems as transducers, which can sustain electronic as well as ionic conduction. Organic semiconductors can offer this possibility. Therefore we suggest that the future of cybernetics might be using more and more organic/bio-organic semiconductors.

On the other hand, the green electronics is also important to sustain a sound and healthy environment. We have already a problem with our electronic waste in the world today. Humanity is today not able to create a sustainable cycle for production, use and end-of-life of our electronic gadgets and instruments. Often such highly valuable products are landing in ordinary garbage dumps, polluting the environment, wasting highly valuable and precious materials as well.

Akio Morita, the founding chairman of SONY has once stated:
"We are moving from consumer electronics to consumable electronics".

Upon this premise we can clearly see that the electronic waste is and will be an increasing problem. By using plastic materials for organic solar cells, organic light emitting diodes etc, we will face a surmounting problem of plastic waste, which is already polluting our oceans. Polyolefins and commodity plastics are often not bio-degradable and impose a problem when they end up in biosphere.

For all this problems, we can suggest the use of bio-degradable and non-toxic bio-organic semiconductors as a sound alternative.

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CARBON DIOXIDE RECYCLING TO

USEFUL CHEMICAL PRODUCTS AND SYNTHETIC FUELS

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Already in 1896, Svante Arrhenius discussed in his work the impact of atmospheric carbon dioxide (CO_2) on the greenhouse effect. According to his calculations, Arrhenius stated even back then the correlation of CO_2 content in the atmosphere and increase of Earth's temperature.[1] Nowadays concerns regarding greenhouse gases, particularly CO_2, and global warming affect politics, economy and society. In comparison to other greenhouse gases such as methane (CH_4) and water vapor, CO_2 has the highest impact on global warming, as the atmospheric residence time is the highest and the content in the atmosphere is moreover on second place after water vapor.[2,3]

CO_2 is generated from the combustion of fossil carbon (oil, gas, coal) and biomass in which energy is released. Due to the finite reserve of fossil-C, another issue is now rising: the convenience to recycle carbon, more than to release it to the atmosphere or dispose it underground. Based on these facts primarily utilization of CO_2 and substitution of fossil fuels as energy carriers have become some of the most discussed topics and have especially drawn attention in scientific community. [4]

Carbon Dioxide as Chemical Feedstock

To reduce atmospheric CO_2 generally two approaches comprising different techniques are considered. In the Carbon Capture and Sequestration (CCS) approach CO_2 is stored in deep rock cavities under sea and land.[5]

Differently, in the Carbon Capture and Utilization (CCU) approach CO_2 is regarded as a carbon feedstock and starting material for artificial fuels and chemicals. With this strategy both issues, depletion of fossil fuels and reduction of CO_2 in the atmosphere, are taken into account.

From the chemical point of view carbon dioxide is a highly stable molecule with the carbon atom. To produce energy rich chemicals from CO2, energy and hydrogen are necessary. Both of them must be generated from renewable energies such as sun, wind, hydropower, geothermal energy. This is a must to achieve CO2 neutrality of such synthetic fuel cycles.

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