

How optical technologies will promote sustainable development and provide solutions to worldwide challenges

Optical technologies can take an example role in stimulating sustainable development and comprehensive answers for all. Part of the physical science branch of optics deals with visible light and vision. This fact makes it very clear to everyone that in certain cases a light turns on if a new solution is found.

Sustainable development is a process for meeting human development goals while maintaining the ability of natural systems in a way that enough natural resources are kept upon which the economy and society depend. Certain resources are necessary to make an invention, find out new mechanisms or to develop machines and devices for a light to turn on. In fact, we are very economically, if we make this effort only once worldwide and all others can profit from it. Everyone should be able to find and access the documentation on how this light turns on, this means how the development was made. Simply said, the knowledge should be kept luminous.

In general, therefore, optical technologies should promote sustainable development in a similar way as other technologies can do. If every step of technological development to find solutions to the worldwide challenges in different fields is done in an economical and watchful way, this will lead to sustained answers that can easily be adjusted upon changes and to different conditions with small efforts and without disturbing natural systems.

As mentioned above, optical technologies have a big advantage for humans, as often we can see what is going on, by eye or with the help of a spectrometer. For many topics, we can thereby tell if something worked out the way we wanted, if it is good or bad according to the level of a light signal.

For example, I worked in the Department of Molecular Biology and Biophysics of the ETH Zürich. There, we did biochemical experiments with GFP, the wonderful green fluorescent protein. After synthesis of the amino acid chain the protein folds into its three-dimensional structure and the amino-acid residues are covalently changed to form the chromophore in the middle of the beta-barrel. A lot is known about this protein and it is used for many applications. The green fluorescence that it shows under UV-light makes it an ideal marker in many cases. We detected the folding of the protein in this way, because once the three-dimensional structure of the amino acid chain is disturbed, the fluorescence stops. Additionally, upon mutation of the protein variants of the protein exist with different fluorescence characteristics. This depends on the one hand on the chemistry of the chromophore, the amino acids side chains that fuse together but also on other side chains of amino acid rests in the beta-strands of the barrel, that are close to the chromophore. Some of the variants are known in the literature, but not the ones that were generated by random mutagenesis for the student course. Additionally, circular permutations of the GFP-protein can be made, by linking the original termini and generating new ones at certain points in the amino acid chain. Based on this further, quite funny developments can be made, that might have some technical meaning. However, only part of the experiments were published. Others are just documented in master theses and laboratory journals. Not many people will think of these again and find them after some time. This might be a result of the fact that science today runs mainly competitive. By the review process for scientific articles, data get lost and thereby the science system does not work in a sustainable way.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In my opinion we should include that all expertise that we acquire today should be documented in a way that it can be reused in the future. Further, today before work with material is starting, we should collect all information that is known on a subject and on side aspects of a subject. Generally, this is easy, as today many databases exist on science and technology. The information can be found by literature and patent searches. However, some information is only noted in books, dissertations, theses or conference abstracts,

that are not included in the widely accessible databases, as mentioned above. To get the possibility to work everywhere on the world in a sustainable way, all experiments including all results, at least from public universities, should be documented and the documentations must be accessible for others. The responsible persons for acquiring the new results must perform in every experiment the necessary controls, not take them from some previous experiment, and publish the outcome directly in an easy and sustainable way. Along these lines, many experiments need not to be done twice or several times and everyone can build directly upon all discoveries. If researchers work altogether instead of being competitive, all resources can be used economically, as time, money and effort for new experimentations is much more than for information gathering.

In summary, particularly in the optical technologies, where often a light turns on, the switch to know how these lights appeared, should never be switched off again. This means, the knowledge should for the future be easily accessible for all, and in particular, the way to this expertise must be in bright light.