WHERE DO WE COME FROM? WHAT ARE WE? WHERE ARE WE GOING? CAN TiO_2 BE THE ANSWER TO ALL THIS?

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Mankind's inability to use carbon resources efficiently and close the carbon cycle lead to a drastic increase in greenhouse gases emissions, such as CO_2, into the atmosphere, which threatens our own existence. Artificial photosynthesis is an emergent strategy to revert the current trend and close the carbon cycle. Metal modified TiO_2 catalysts, when pumped in the UV region are able to convert CO_2 and H_2O to a plethora of organic molecules of interest, such as methane, methanol and hydrogen. The fundamental understanding of these chemical transformations will disclose TiO_2 surface reactivity secrets, which makes it the most used photocatalyst. Furthermore in order to outperform nature's process, developments in the three primary processes are required. The three primary processes are:

- Solar light harvesting
- Reducing cycle
- Oxidative cycle

The present work shows the strategy followed in our group to improve the three processes. In respect to solar light harvesting, we successfully tested plasmons structures as light harvesters. In the reducing cycle, we determine the primary role of metal co-catalyst, whereas in the oxidative cycle we tested a noble Mn complex that is able to increase the yield of oxygen producing by disproportionation of hydrogen peroxide (unwanted reaction of O_2 with electrons). The advances were only possible by experiments carried out in the time-domain, which were performed at the IR and hard X-ray beam lines of the Swiss Light Source. The methodologies used will be presented. It is my believe, that significant gains can be made in artificial photosynthesis, if one can understand the time-dependent aspects of the process.