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PHOTOREDUCTION OF CARBON DIOXIDE WITH SEMICONDUCTOR PHOTOCATALYSTS INITIATING TWO PHOTON PROCESSES

Kirthi Tennakone, Parakrama Abeysooriya, Damayanthi Pathinayaka,
and **H. A. Gnanaratne**
(*Dept. of Physics, Ruhuna University College, Matara*)

Artificial simulation of photosynthesis seems to be the only long-term solution to the fuel crisis and carbon dioxide pollution. It is known that aqueous semiconductor powder dispersions have the capacity to photoreduce

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carbon dioxide to free energy rich compounds such as formaldehyde and methyl alcohol. The quantum conversion efficiency of such systems with familiar stable semiconducting materials is low, because they predominantly excite only one photon process with relatively high energy (uv or near uv) photons that are deficient in sunlight. The success of natural photosynthesis depends on the efficient utilization of several low energy photons (optical region) for the reduction of one molecule of CO_2.

We have noted that two types of semiconducting photocatalysts can be produced to promote two photon processes in the photoreduction of CO_2. (1) Composite semiconducting particles where one component undergoes reversible photo-oxidation and reduction (2) Complex crystalline and molecular semiconducting solids showing multiple absorption bands, that initiate two photon processes via exciton-exciton interactions.

After testing a large number of substances that seemed promising on theoretical considerations, we found that processes (1) and (2) were practically realized to a high degree in mercury coated n - TiO_2 and n-HgCO $(CNS)_4$ respectively. Aqueous suspensions of these catalysts photoconvert CO_2 to H.CHO with a quantum yield 10 - 100 greater than the yield obtained with catalysts based on single photon reactions.