【Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area)】
Science and Engineering

Title of Project : Application of Cooperative Excitation into Innovative Molecular Systems with High-Order Photofunctions

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【Purpose of the Research Project】

Molecules in the electronic excited state take important roles in various photo-functional processes, such as photo-energy and photo- material conversions. For molecules in condensed phase, however, three general restrictions limit the efficient utilization of light energies. First, molecules in higher excited states usually very rapidly relax to lower electronic states (Kasha's rule) and some portion of the absorbed photon energy is diminished in this relaxation. Second, a large number of the molecules excited in assemblies undergo fast annihilation and only a small number of excited state molecules can remain, leading to the loss of the number of photons absorbed in the system. In addition, the electronic state accessible through the one-photon absorption is limited by the optical selection rule and we cannot access various dark electronic excited states of molecules.

The purpose of the present project is to develop and advance excitation methods and molecules/molecular assemblies that can overcome these three restrictions, by exploring methods beyond the conventional paradigm, "one-photon and one-molecule outcomes"; such as multiple excitation, multiphoton absorption, strong modulation of electronic states, coherent and cooperative responses of molecules, and rational design of molecular assemblies. By integrating these investigations, we aim to acquire general principles on "photosynergetics" enabling more effective utilization of the light energy in molecular systems.

【Content of the Research Project】

The present project consists of three groups (A01, A02 and A03) working in intimate collaboration to attain the purpose of the project.

The group A01 aims to elucidate reaction and relaxation processes in higher and dark excited states, and exploration of advanced methods to access these electronic states.

The purpose of the group A02 is to develop molecular systems that ensure "additivity" and "integration" without loss of the photon energy.

Through these investigations, we explore the rational and novel principles for designing sequences of reactions and structures of molecular assemblies.

The target of the group A03 is the realization of photoresponsive molecular assemblies in meso– and macroscopic scales, by applying the cooperative excitation methods and coherently and concertedly designed sequences.

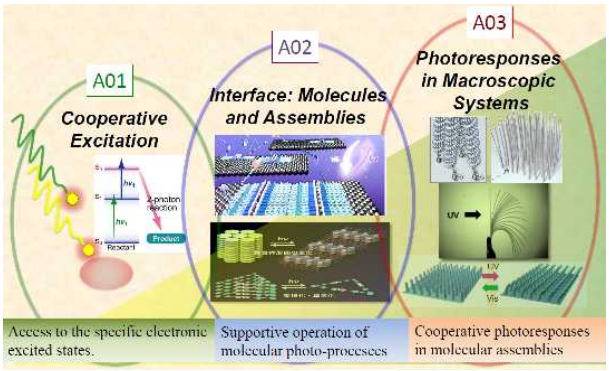

Fig.1　Organization of the project.

【Expected Research Achievements and Scientific Significance】

The information obtained in the present project provides important principles for designing the photosynergetic systems where the cooperative interaction among photons and molecules are positively utilized. These principles overcome the three restrictions in the utilization of photo energies and will contribute to the creation of advanced molecular systems relating to various photo-functions.

【Key Words】

Cooperative excitations: methods to access specific excited states unattainable by the one-photon optical transition.

【Term of Project】　FY2014-2018

【Budget Allocation】　961,100 Thousand Yen

【Homepage Address and Other Contact Information】

http://photosynergetics.jp