

## Artificial Photosynthesis (2)

In the United States President Obama announced to spend 15 billion yen over 5 years to develop fuel generation through artificial photosynthesis. For this session we invited the leader of this project, Professor Nathan Lewis, director of the Joint Center for Artificial Photosynthesis (JCAP) and professor at the California Institute of Technology, to talk about current research and future developments of artificial photosynthesis research at JCAP. For Osaka City University, Professor Nobuo Kamiya, professor at the Advanced Research Institute for Natural Science and Technology and director of the Research Center for Artificial Photosynthesis (ReCAP), will explain the detailed structure analysis of the MnCaO<sub>5</sub> cluster, the biological catalyst that generates oxygen by splitting water produced by plants, and current research and future developments at ReCAP. Each lecture will take 1 hour (total 2 hours), including time for questions and answers.

### Current research and future developments at JCAP

**Nathan Lewis** (Professor, California Institute of Technology, USA)



Dr. Nathan Lewis, the George L. Argyros Professor of Chemistry, has been on the faculty at the California Institute of Technology since 1988 and has served as professor since 1991. He has also served as the Principal Investigator of the Beckman Institute Molecular Materials Resource Center at Caltech since 1992, and is the Principal Investigator of the Joint Center for Artificial Photosynthesis, the Energy Innovation Hub in Fuels from Sunlight. From 1981 to 1986, he was on the faculty at Stanford, as an assistant professor from 1981 to 1985 and as a tenured Associate Professor from 1986 to 1988. Dr. Lewis received his Ph.D. in Chemistry from the Massachusetts Institute of Technology.

Dr. Lewis has been an Alfred P. Sloan Fellow, a Camille and Henry Dreyfus Teacher-Scholar, and a Presidential Young Investigator. He received the Fresenius Award in 1990, the ACS Award in Pure Chemistry in 1991, the Orton Memorial Lecture award in 2003, the Princeton Environmental Award in 2003 and the Michael Faraday Medal of the Royal Society of Electrochemistry in 2008. He is currently the Editor-in-Chief of the Royal Society of Chemistry journal, Energy & Environmental Science. He has published over 300 papers and has supervised approximately 60 graduate students and postdoctoral associates. His research interests include artificial photosynthesis and electronic noses.

The Joint Center for Artificial Photosynthesis is the U.S. Department of Energy's Innovation Hub in Fuels from Sunlight. Its goal is to perform the research and development to demonstrate a complete artificial photosynthetic system that directly produces fuel from sunlight, with an efficiency at least ten times greater than current natural photosynthesis. JCAP work is focused on the discovery and development of new catalysts, light absorbers, membranes, and interfaces needed to demonstrate an artificial photosynthesis capability, and to integrate these functions in one synergistic unified team effort. This presentation will describe the organization, goals, mission, and accomplishments of JCAP as well as specific examples of recent important developments in artificial photosynthesis that will underpin the development of this technology into a useful, scalable, global clean energy system.

### Detailed structure analysis of oxygen-evolving center: Mn<sub>4</sub>CaO<sub>5</sub> cluster in photosynthesis, and current research and future developments at ReCAP



**Nobuo Kamiya** (Professor, Osaka City University Advanced Research Institute for National Science and Technology)

After obtaining a doctor degree of science at Nagoya University, he started to design the first synchrotron radiation beamline for macromolecular crystallography at the Laboratory for High Energy Physics, Tsukuba. From 1985, as a researcher of RIKEN he constructed a structural biology beamline at SPring-8, Harima. In 2005 he became professor of the Graduate School of Science at OCU, and in 2010 professor at OCARINA. He has been working with Professor Shen of Okayama University on X-ray crystallography of photosystem II from 1990.

Photosystem II (PSII) in the thylakoid membrane of plants and algae performs light-induced electron transfer and water-splitting reactions, which lead to the formation of molecular oxygen in photosynthesis. The oxygen-evolving center (OEC) of PSII is a metal cluster containing four Mn and one Ca atoms, and elucidation of the reaction mechanism of OEC is very important to develop novel catalysts for artificial photosynthesis. In his lecture, he will discuss the relations between the oxygen-evolving catalyst and other components for realizing the artificial photosynthesis device.

### Chair



**Hideki Hashimoto** (Professor, Osaka City University Advanced Research Institute for National Science and Technology)

Professor Hashimoto earned a doctorate degree of science from Kwansei Gakuin University Graduate School of Science. He worked as an assistant professor at Osaka City University's Faculty of Engineering, an associate professor at Shizuoka University's School of Engineering and visiting associate professor at University of Glasgow. In 2002, he became professor at Osaka City University's Graduate School of Science and he has served as project leader at the Osaka City University Advanced Research Institute for Natural Science and Technology (OCARINA) since 2010. Currently, Professor Hashimoto is the president of the International Carotenoid Society as well as the director of Osaka City University Media Center.