VIDEO ARTICLE

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Structure Control of Metal Clusters and their Application in Energy and Environmental Catalysts

Yuichi Negishi

Department of Applied Chemistry, Faculty of Science, Tokyo University of Science, Kagurazaka, Shinjuku−ku, Tokyo 162−8601, Japan

Corresponding author: E-mail: negishi@rs.tus.ac.jp

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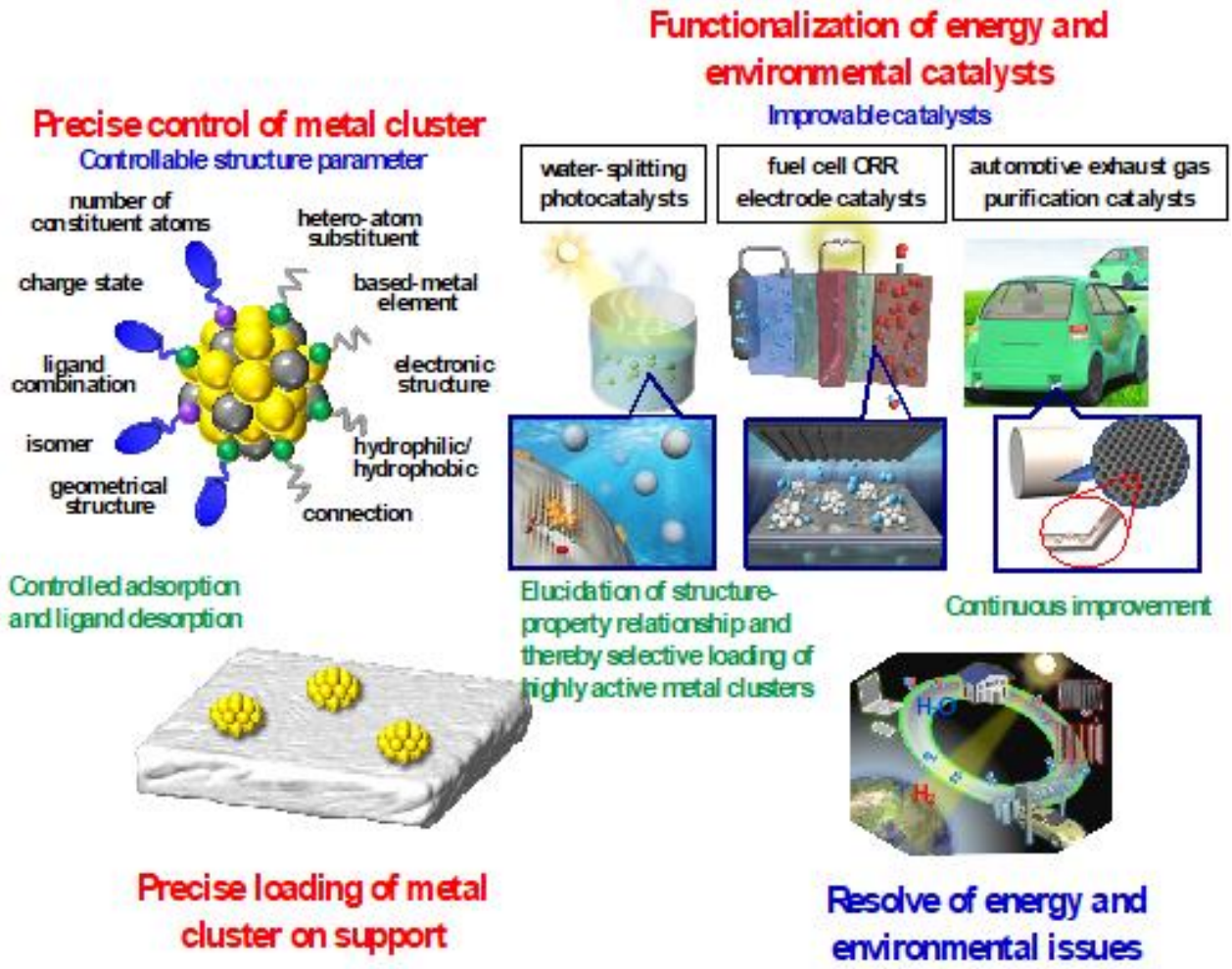
Graphical Abstract



Abstract

In order to build a sustainable society, it is indispensable to create new innovative materials that can solve the problems of the current society. Strict control of the structure of materials at the nanoscale is expected to lead to the creation of such materials. Ultrafine metal clusters, in which several to several dozen metal atoms are aggregated, have novel electronic/geometric structures and physicochemical properties/functions that are different from those of bulk metals composed of the same elements. In addition, doping (alloying) of different elements to these metal clusters results in a variety of structures, properties, and functions. Thus, metal clusters have high potential as constituent units for innovative materials. However, in order to understand the functions of metal clusters and to apply them as materials, it is essential to establish techniques to strictly control the chemical composition and geometric structure of metal clusters. The candidate has established several techniques to strictly control the chemical composition and geometric structure of metal clusters. He also succeeded in establishing a method to control the supported metal clusters to enhance the functionality of advanced water splitting photocatalysts, fuel cell electrocatalysts, and automotive exhaust gas purifying catalysts. Accordingly, the candidate has achieved the highest water-splitting activity for UV-responsive $BaLa_4Ti_4O_{15}$ water-splitting photocatalysts, created platinum electrocatalysts with higher catalytic activity for oxygen reduction than those currently used in fuel cells, and succeeded in developing highly functional catalysts for automotive exhaust gas purification. These candidate's research is unique in that it consistently achieves the atomic-level control of the metal clusters throughout the entire research, from synthesis to control on the support. Since the candidate's research, it has become possible to precisely synthesize various types of metal NCs, and this has led to a great deal of knowledge about structure-property relationships in metal clusters and the development of highly functional energy and environmental materials based on their properties.

Keywords: Metal clusters; precise control; water-splitting photocatalysts; fuel cell; automotive exhaust gas purification catalysts.

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Biography of Presenting Author

Yuichi Negishi is a Professor in the Department of Applied Chemistry at Tokyo University of Science. He received his Ph.D. degree in Chemistry in 2001 under the supervision of Prof. Atsushi Nakajima at Keio University. Before joining Tokyo University of Science in 2008, he was employed as an Assistant Professor at Keio University (with Associate Prof. Atsushi Nakajima) and at the Institute for Molecular Science (with Associate Prof. Tatsuya Tsukuda). His current research interests include the precise synthesis of stable and functionalized metal nanoclusters and their applications in energy and environmental materials. He has delivered over 150 invited lectures. Total citations of his papers (> 190) are over 12,000 and among his papers, 36 papers were selected as a Cover image (Front or Back Cover). He has been awarded several prizes, including PCCP Prize for Outstanding Achievement of Young Chemists in Physical Chemistry and Chemical Physics (Royal Society of Chemistry) (2007), The Chemical Society of Japan Award for Young Chemists (Japan Chemical Society) (2008), Japan Society for Molecular Science Award for Young Scientists (Japan Society for Molecular Science) (2012), The Journal of Physical Chemistry Letters Most Valued Reviewer Award (American Chemical Society) (2016), Yagami Prize (Keio University) (2017), Distinguished Award 2018 for Novel Materials and Their Synthesis (IUPAC) (2018), International Investigator Awards of the Japan Society for Molecular Science (Japan Society for Molecular Science) (2020), and The Chemical Society of Japan Award for Creative Work for 2021 (Japan Chemical Society) (2021).

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