【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Chemistry)

Title of Project : Creation of Superatoms Based on the Precision Inorganic Synthesis and Elucidation of its Function

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Research Area : Macromolecular Complexes , Advanced Materials Chemistry
Keyword : Dendrimer, Cluster, Superatom

【Purpose and Background of the Research】

The precision metal synthesis that manipulates elements freely at the atomic level using as many as nearly 90 types of metal elements as raw materials provides a dramatic expansion and evolution of nanomaterials in the next-generation, but it has not yet been realized.

In this study, main researchers take an initiative in creating subnanosized alloy particles by making full use of the precision metal accumulation and reaction method that they have developed on his own account. The subnanosized alloy particle is a material which has not been explored so far and is exhibit multi-element properties. Their functions will also be examined, from which a new substance group will be explored.

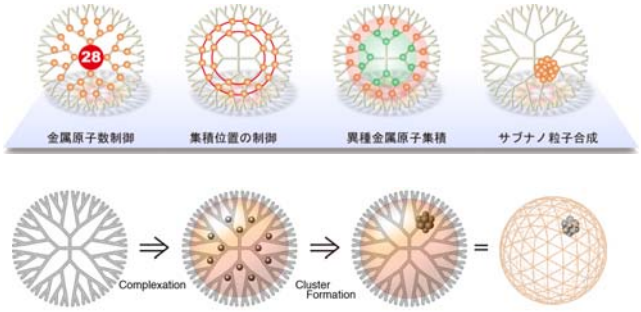

Fig.1 Metal Assembling and Synthesis of Subnano Particles

【Research Methods】

This research is intended to propose new inorganic nanomaterials through the following three items: (1) establishment of a "precision metal accumulation and synthesis method" as a precision inorganic synthesis process; (2) creation of subnanosized metal particles; and (3) the elucidation of the functions of subnanosized metal particles.

1. Establishment of the precision metal accumulation and synthesis method: designing and synthesizing a new dendrimer template to extend the variations of metal accumulation.
2. Creation of subnanosized metal particles: establishing the synthesis of subnanosized metal particles and the oxide fine particles to elucidate their detailed structures and clarify their basic physical properties.
3. Elucidation of functions of subnanosized particles: elucidating the functions of precision subnanosized particles such as light-emission and catalytic functions, and demonstrating their usefulness.

【Expected Research Achievements and Scientific Significance】

An abundance of metallic elements with nearly 90 types can provide infinite combination. The precision inorganic metal synthetic chemistry which combines metal elements at the atomic level can create inexhaustible nanomaterials.

Discovery of superatom enables the replacement of properties of an element with another element, which can create a new substance group. Given the wide range of applications of present nanosized particles, subnanosized metal particles could also be widely spread into the current science and technologies. For example, they are closely related to urgent issues such as catalysts, fuel cells, memories, and solar cells, and expected to be useful for new technologies to support the next generation.

【Publications Relevant to the Project】

・"Magic Number Pt13 and Misshapen Pt12 Clusters:Which One is the Better Catalyst ?" T. Imaoka, H. Kitazawa, W.-J. Chun, S. Omura, K. Albrecht, K. Yamamoto, *J. Am. Chem. Soc.* **2013**, 135, 13089 -13095.
・"Formation of a Pt12 Cluster by Single-Atom Control That Leads to Enhanced Reactivity: Hydrogenation of Unreactive Olefins" M. Takahashi, T. Imaoka, Y. Hongo, K. Yamamoto *Angew. Chem. Int. Ed.* **2013**, 52, 7419-7421.
・"Size-specific catalytic activity of platinum clusters enhances oxygen reduction reactions" K.Yamamoto, T. Imaoka, W. Chun, O. Enoki, H. Katoh, M. Takenaga, A. Sonoi, *Nature Chem.* **2009**, 1, 397-402.
・"Quantum size effect in TiO2 nanoparticles prepared by finely controlled metal assembly on dendrimer templates." N. Satoh, T. Nakashima, K. Kamikura, K. Yamamoto, *Nature Nanotechnol.* **2008**, 3, 106-111.

【Term of Project】 FY2015-2019

【Budget Allocation】 154,500 Thousand Yen

【Homepage Address and Other Contact Information】

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