



# Hybrid Materials Unit

## Overview

Nanoparticles, measured in units of one billionth of a meter, are extensively applied in engineering. However, we have yet to fully clarify the properties of sub-nanoparticles, particles that are even smaller than nanoparticles. This has hindered the development of synthesis methods. It is expected that if we can freely structure sub-nanoparticles by programming the number of atoms in them and the compounding ratio of constituent elements, then we can create substances with properties that are completely different from what we have now. Specifically, there is no known method for integration and combination of atoms of different metallic elements. Considering the more than 90 metallic elements in the periodic table of elements, the potential combinations are infinite. The Hybrid Materials Unit aims to create new materials using a highly precise hybrid method of blending metallic elements utilizing uniquely developed dendritic polymers (dendrimers) with the goal of opening the door to a new field that will serve as the base for next-generation functional materials.

## Research goals

Dendrimers have a three-dimensional structure with internal voids like the spaces between the branches of a tree. They are high-molecule structures with regular geometrical shapes and potential gradient. In the past, metallic sub-nanoparticles were thought to have been randomly arranged. However, the Hybrid Materials Unit was the first to discover that dendrimers have a stepwise complexation that extends from their inner to outer layers. The unit also established a method of synthesis that allows flexible and accurate control of the number, arrangement, ratio, and order of similar and dissimilar elements. The unit calls this the atom hybrid method. By applying this method, the Hybrid Materials Unit aims to produce new materials that are beyond our imagination, clarify their properties, and discover the number of atoms and correlations with different types of elements. The unit also aims to systematize new materials and create a next-generation material library leading to the future design of materials.

Research Unit Leader

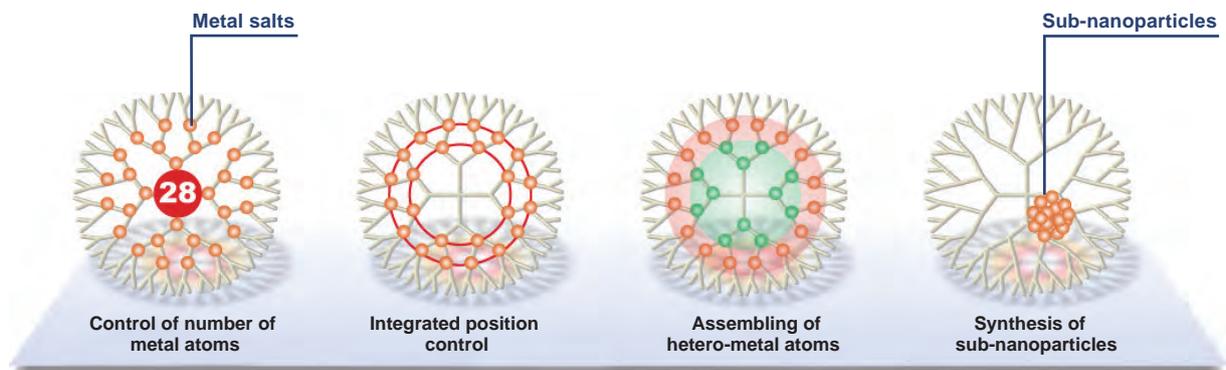
**Kimihisa  
Yamamoto**



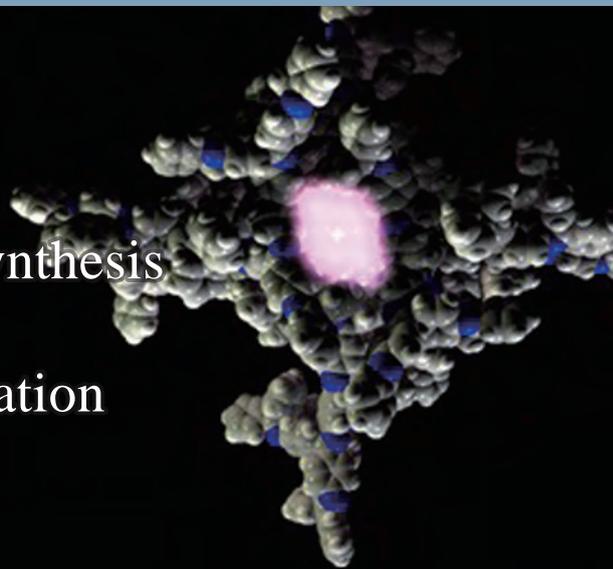
### Profile

- 2016 Professor, Institute of Innovative Research, Tokyo Institute of Technology
- 2010 Professor, Chemical Resources Laboratory, Tokyo Institute of Technology
- 2002 Professor, Faculty of Science and Technology, Keio University
- 1997 Associate Professor, Faculty of Science and Technology, Keio University
- 1990 Doctor of Engineering, Graduate School of Science and Engineering, Waseda University
- 1989 Research Associate, School of Science and Engineering, Waseda University
- 1985 Bachelor of Engineering, Department of Applied Chemistry, School of Science and Engineering, Waseda University

## Atom hybrid method



# Progressing in sub-nanoparticle synthesis and discovering new materials with functions beyond our imagination



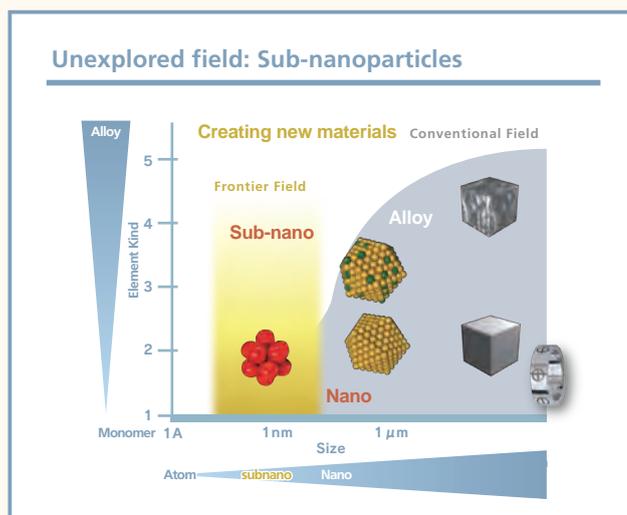
## Q Why was this research unit established?

Providing a spacious and secure environment for researchers contributes to innovation and advancement. The Hybrid Materials Unit facilitates consistent research, synthesis, and measurement, and serves as a space for discussion and information sharing among scientists. The unit also considers ways of supporting young chemists and establishing new fields of chemistry.

## Q What are the strengths of this research unit?

While other researchers succeeded in synthesizing sub-nanoparticles, the Hybrid Materials Unit established a method that allows researchers to freely determine the number of atoms and handle them stably. Although global competition is fierce in the field of sub-nanoparticle research, the unit is still far ahead of others in the area of efficient synthesis. The unit continues to move forward in dendrimer synthesis to discover new materials with heretofore unimaginable functions.

The dendrimers we discovered and patented make it possible to easily form unified integrated structures by programming the number of atoms and the arrangement of a wide range of metals. Of the 112 elements, there are about 90 metallic elements. Among these 90 metallic elements, there are 65 metallic materials that Tokyo Tech can handle stably. In other words, the unit has the potential to create new materials through an infinite number of combinations of such metallic materials.



## Q What is the path to achieving the unit's goals?

The Hybrid Materials Unit sets *synthesis*, *structure*, and *function* as the three major pillars as it sheds light on the unexplored field of sub-nanoparticles, aiming to systematize it as a new academic area. The unit confidently takes the lead toward mass synthesis processes as it considers practical implementation in society. The research structure was established in 2015. In 2016, the unit will promote research within the established structure, focusing on advancing the individual research topics of the group leaders.

Contact us

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