TSUKAMOTO LAB.

New Chemistry of Quantum-sized Materials

Department of Materials and Environmental Science

Quantum-sized Materials Chemistry
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Nanoscience Between Solids & Molecules

Fundamental researches

T. Tsukamoto et al.
Nature Commun. **2018**
Nature Commun. **2018**
Nature Commun. **2019**
Nature Rev. Chem. **2021**
Acc. Chem. Res. **2021**

Synthesis
Theory

New Materials

Property
Function

Applicational researches

T. Tsukamoto et al.
Angew. Chem. Int. Ed. **2019**
J. Am. Chem. Soc. **2020**
Angew. Chem. Int. Ed. **2020**
Angew. Chem. Int. Ed. **2022**

"Quantum-sized materials," which are ultra-small nanoparticles (1 nm) undergoing the remarkable quantum size effect, are expected to exhibit unique properties not found in conventional materials. In our laboratory, we investigate the science of new material group located at the boundary between solids and molecules by fusing experimental and theoretical approach.

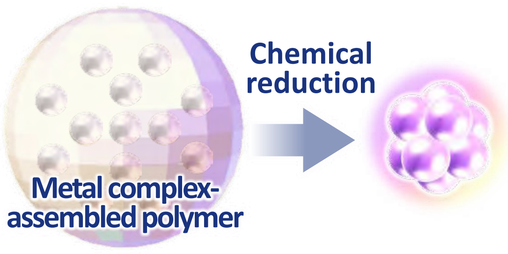
★ Experimental Design of Quantum-sized Materials

Development of new synthetic method

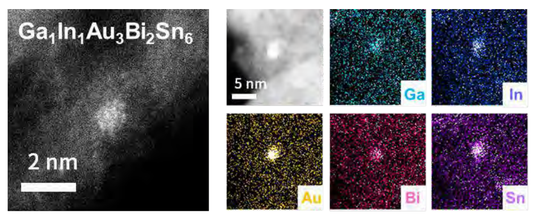
In our laboratory, we are developing techniques to synthesize the **quantum-sized materials with controlled atomicity and element composition** by utilizing the nano-sized reaction fields inside polymer capsules. By applying this method, we have succeeded in discovering **physical and chemical properties unique to quantum-sized materials**, such as unusual oxidation states and high catalytic abilities.

Development of Precise Template synthesis

[*Nature Communications* **2018**]



Template synthesis using nanocapsules



1 nm particle composed of 5 metal elements

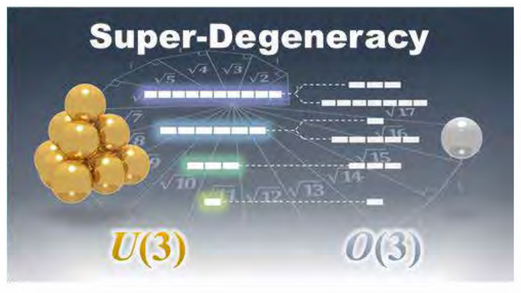
★ Theoretical Design of Quantum-sized Materials

Development of new design theory

In our laboratory, we are developing a new theory that simply predicts structure and property of the quantum-sized materials by combining computational chemistry and group theory. We have succeeded in finding the **periodicity in molecular properties** in such materials, and in discovering the first-ever **chemical substances with anomalously-degenerate electronic states** originating from mathematical factors.

Proposition of Higher-order periodic table

[*Nature Communications* **2019**]



Discovery of Super-degenerate clusters

[*Nature Communications* **2018**]