# Abstract of Doctoral Dissertation

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Title of Doctoral Dissertation

Control of Plasmonic Chiroptical Properties by the Design of Gold Nanostructures
(金ナノ粒子の構造設計によるプラズモンキラリティの制御)


Designing and fabricating plasmonic chiral structures through the chiral units or chiral assembly of achiral units constitute an extraordinarily dynamic research domain. This dynamism is particularly evident in the rapid advancements seen in the construction of blocks, templates, and strategies in recent years. Presently, research interests in this field have progressively shifted towards amplifying and dynamically controlling chiroptical activity. This is driven by the requirements of future applications in nanophotonics and sensing, necessitating switchable and adaptive chiral responses. However, in this research process, there are still numerous unresolved issues. One key challenge is the lack of developed effective strategies for amplifying and tuning the chiroptical activity of discrete plasmonics.

This thesis primarily presents a study on controling the plasmonic chiroptical properties through meticulous design of particle structures. Firstly, by constructing a metal-molecule-metal core-gap-shell structure, I confirm that the enhancement of chiroptical response can be achieved through the strong coupling between chiral molecules in nanogaps or nanocavities and the enhanced near-field electromagnetic field within hotspots. Secondly, by coating the surface of the structure with an active dielectric layer and subjecting it to pH and potential stimuli, the results demonstrate that the modulation of chiroptical response can be realized through changes in the external dielectric environment. These research findings provide further insights into understanding and manipulating the chiroptical properties of gold nanostructures.

The next challenge will focus on the development and optical tuning of intrinsic chiral nanoparticles and assemblies. This is because the progressive scale of asymmetry will bound to impart the system with more pronounced chiroptical properties, favouring the realization of further translation to applications. Despite numerous reports on chiral growth using simple-shaped particles as seeds, the corresponding relationship between the chiroptical properties and the geometric morphology of the particles has not been clearly established. This may necessitate a more comprehensive consideration of complex and multi-level particles. To address this, I introduced a well-defined gold octahedral nanoframe as the seed for chiral growth. Current research has obtained preliminary insights into the distorted morphology of the particle surface. The specific chiroptical properties will be further controlled through the optimization of geometric parameters.