Development of Vertical-Imaging Circular Dichroism Apparatus for Characterizing the Structure of Aggregated Biomolecules

Kuya Aoyama[a], Satoshi Hashimoto[a], Mohamed Ibrahim[b], and Koichi Matsuo[a,b]

[a]*Graduate School of Advanced Science and Engineering, Hiroshima University*
[b]*Research Institute for Synchrotron Radiation Science, Hiroshima University*

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Circular dichroism (CD) measurements in the vacuum-ultraviolet region using synchrotron radiation are widely utilized for the precise structural and functional research of biomolecules in solutions. However, CD measurements of solid and semi-solid biomolecules, such as amyloid fibrils (which are causative materials of Alzheimer's disease), liquid-liquid phase separation involved in cellular and biological function regulation, and polymer hydrogels, remain technically difficult. The reasons are as follows:

1. For solid samples such as aggregates, accurate CD measurements are difficult because anisotropic optical effects, including linear dichroism (LD) and linear birefringence (LB), interfere with the CD signals.

2. Since the beam size is larger than that of the aggregates, the obtained CD spectrum reflects an averaged signal including both aggregated and non-aggregated samples within the beam spot.

In this study, to resolve these issues, we developed vertical-imaging circular dichroism apparatus (ViCD) by the usage of new optical system [1] which can eliminate sample anisotropy and by the installation of focusing mirrors which can minimize the beam spots and realize the spatially resolved measurements.

To verify the performance of the new optical system, first, we measured the CD spectrum of camphor sulfonic acid solution, a standard CD sample, using new system and confirmed an intensity ratio of 1:2 at 290 nm and 190 nm, and second, we measured the CD spectrum of some L-alanine thin films prepared by a vacuum deposition method and confirmed the elimination of anisotropy effects such as LD and LB. Further, we conducted spatially resolved measurements using focusing mirrors for the alginate-gum arabic gel and characterized structurally heterogeneous regions depending on high gum arabic concentration.

These results demonstrate that the ViCD system developed here successfully visualizes the spatial heterogeneity of solid and semi-solid biomolecules without interference from anisotropy.

REFERENCE

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