Protein Detection and Quantitation Based on the Absorption Extent of Polarized Light by Dye-Doped Liquid Crystal

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Abstract

A quantitative protein assay using dye-doped liquid crystal (DDLC) as the sensing platform was developed. In this study, the black dye with high dichroic ratio and wide absorption band was used as the dopant in the DDLC mixture to promote the sensitivity of the biosensing system. According to the absorption and anisotropic features of the DDLC, results based on transmission spectra indicate that the concentrations of the commonly used protein standard bovine serum albumin (BSA), ranging from 10^{-6} to 10^{-2} g/ml are detectable through the changes in the transmittance. The resolution power of the proposed DDLC-based biosensor for BSA concentrations in such a detectable range can further be increased when setting a polarizer on the spectrometer to produce linearly polarized incident light.

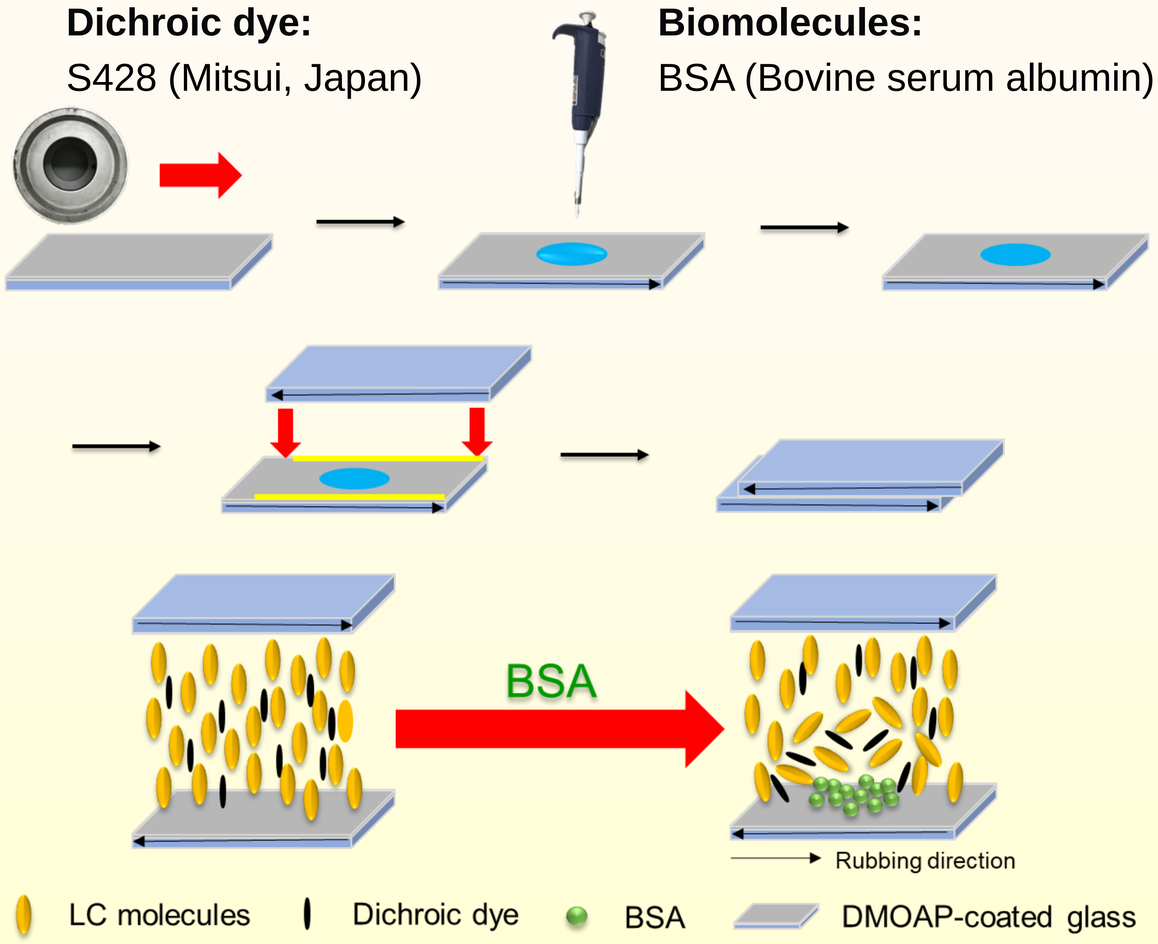
Experiment

Cell configuration:
Alignment layer: DMOAP
cell gap: 8.0 ± 0.5 μm

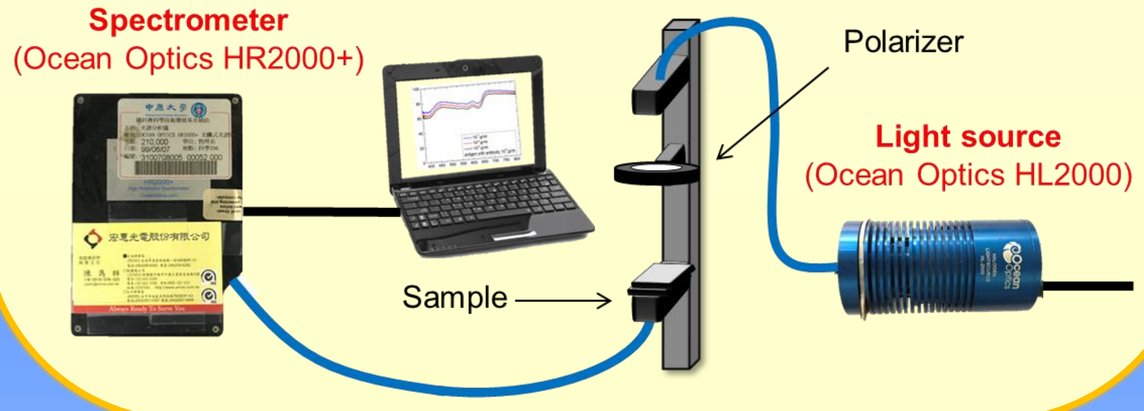
Liquid crystal:
E7 (Δn = 0.2255)

Dichroic dye:
S428 (Mitsui, Japan)

Biomolecules:
BSA (Bovine serum albumin)

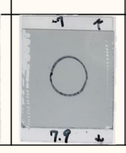
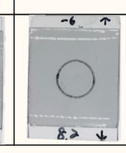
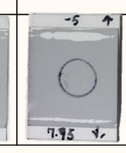
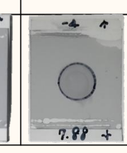
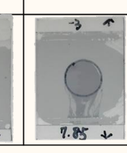
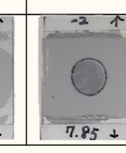
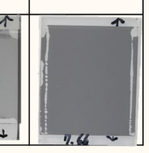


Setup for spectral measurements

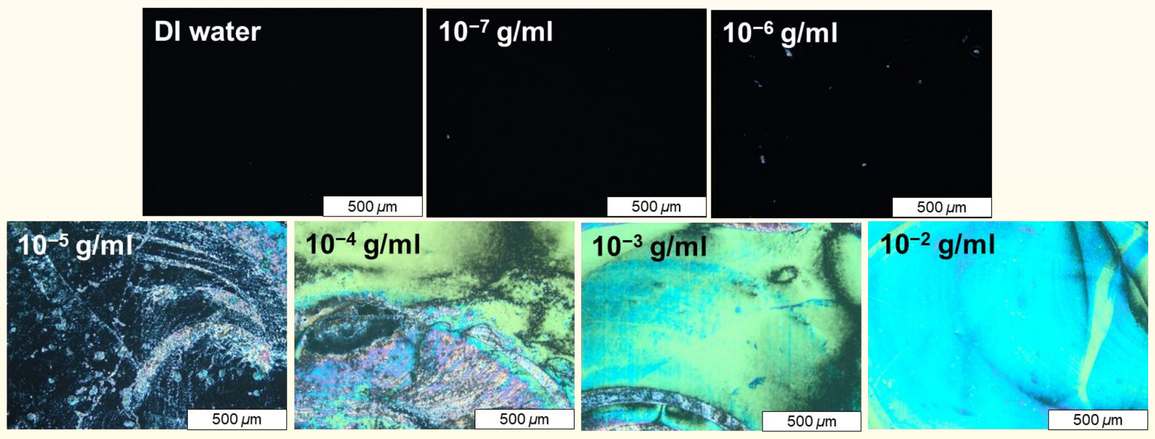


Results and Discussion

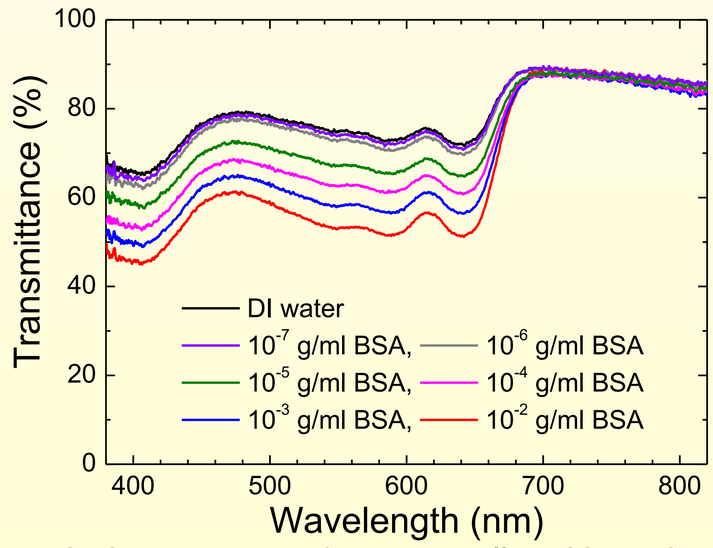
Actual samples

BSA concentration (g/ml)	DMOAP	DI water	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	SE2170
Cell appearance									

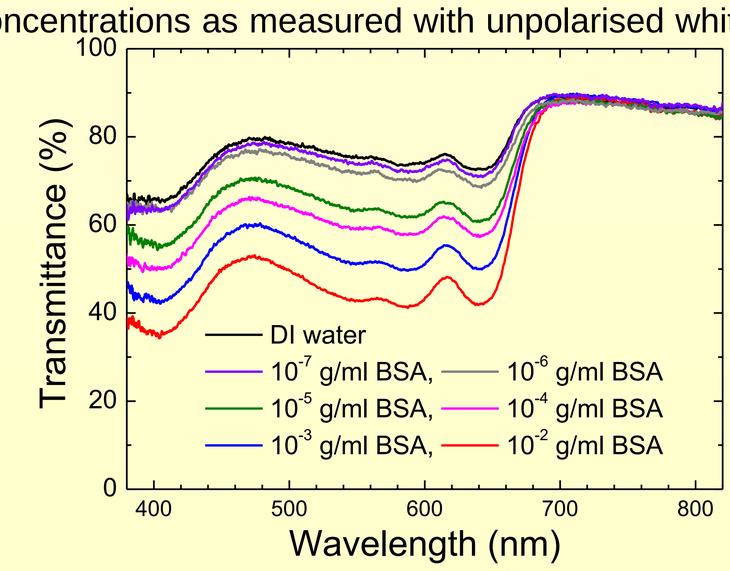
Comparison of the grey level of DDLC cells in the presence of various concentrations of BSA, which was immobilized within the circled area. A DDLC cell coated with the heterotropic aligning reagent SE2170 was included to represent the grey scale when DDLC molecules were planarly aligned.



Optical textures of DDLC in the presence of various BSA concentrations when observed under a polarizing optical microscope with crossed polarizers. The rubbing direction of the DDLC cell was parallel to the transmission axis of either polarizer. Scale bar: 500 μm.



Transmission spectra of DDLC cells with various BSA concentrations as measured with unpolarised white light.



Transmission spectra of DDLC cells with various BSA concentrations. Polarization of incident light is parallel to the rubbing direction.

Conclusions

- We developed a biosensing method using a dye-doped liquid crystal. The working system was demonstrated with a black dichroic dye possessing high dichroic ratio and a absorption band from 400 nm to 700 nm.
- Consider the insertion of a polarizer between the sample and the transmission spectrometer. When the axis of the polarizer was parallel to the rubbing direction, the absorbance of black dyes was enhanced, resulting in an increase in the slope of the calibration curve for BSA concentration.
- These results suggest that the intrinsic absorption properties of the dichroic dye can be exploited in protein quantitation, and polarized light can be utilized to improve the sensitivity of detection.

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