# Evaluation of Light Scattering in Dye-doped Polymer/Liquid-Crystal Composite Film (PLCF)

Zhengyi Gou* Seiji Fukushima* Hirotsugu Kikuchi** Toshio Watanabe* Tsutomu Nagayama *
(*Graduate School of Science and Engineering, Kagoshima University) (**IMCE, Kyushu University)

## 1 Introduction

A polymer/liquid-crystal composite film (PLCF) has excellent extinction and polarization independency at both visible and infrared wavelengths when dichroic dyes are doped. In this paper we report extinction ratio dependence on wavelength and on scattering angle of the dye-doped PLCF. The extinction is originated from only scattering or a scattering/absorption combination.

## 2 Principles and Experiments

The mechanisms of optical attenuation in dye-doped PLCFs are mainly considered to be scattering [1]. The scattering mechanism consists of Rayleigh and Mie scattering. Rayleigh scattering occurs when the particle size is much smaller than the wavelength of radiation and its extinction depends on scattering angle. Mie scattering occurs when the particle is comparable to wavelength of radiation. We measured optical intensities at several scattering angles to evaluate the light scattering of the dye-doped PLCFs. The dopants are phtalocyanine derivative (SIR103), metal complex (SIR132), anthraquinone derivative (M370), and azo derivative (M618). We have four dye-doped samples and one undoped. We used three laser sources with wavelengths of 405, 532, and 635 nm but the results of 405 nm are not shown.

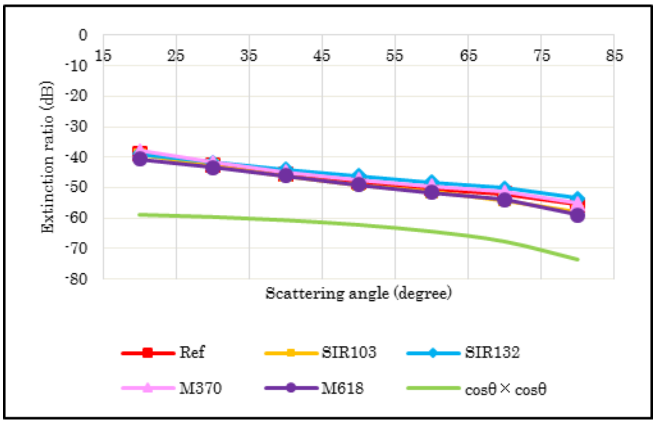


Fig. 1 Extinction ratio dependence on scattering angles. (λ = 635 nm)

## 3 Results and Discussion

The extinction ratios decrease by the increasing of scattering angles θ, as shown in Figs. 1 and 2 at wavelengths of 635 and 532 nm, respectively. The extinction ratio is approximately proportional to $\cos^2\theta$. This indicates that the scattering mechanism of all the samples is dominated by Rayleigh scattering. In Fig. 1, all the calculated correlation coefficients are over 0.92, which indicates that the results are reasonably reliable.

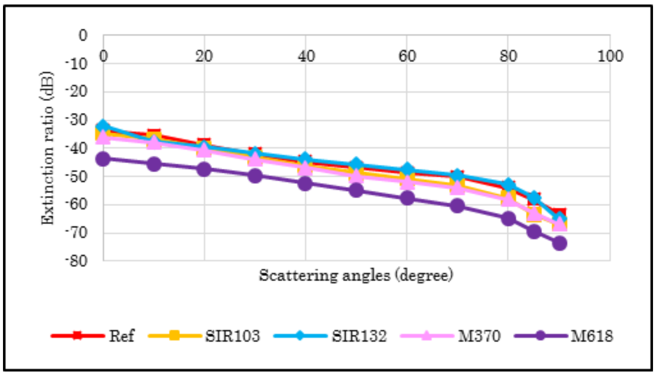


Fig. 2 Extinction ratio dependence on scattering angles. (λ = 532 nm)

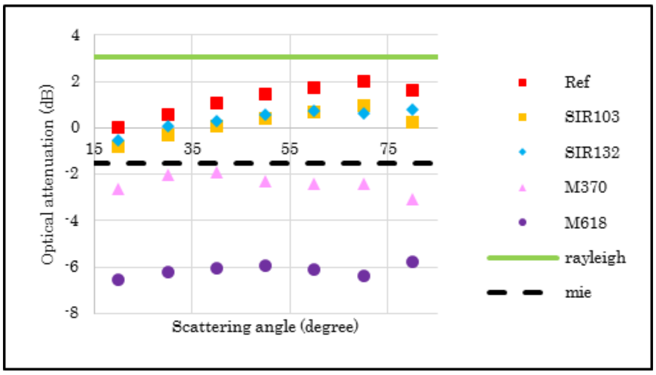


Fig. 3 Optical attenuation ration dependence on scattering angles.

Intensity ratios at the wavelengths of 532 to that at 635 nm are shown in Fig. 3. A green solid line and a black dashed are theoretical values of the Rayleigh and Mie scattering, respectively. Most of the results except for the M370 and M618 samples are in between the two theoretical lines, which indicates a mixed type of scattering. The M370 curve is relatively close to the Mie line. Since an absorption wavelength of M618 is 530 nm, very close to the laser wavelength of 532 nm, the ratio of M618 should be explained by the combination of scattering and absorption.

## 4 Conclusion and Acknowledgment

Optical attenuation dependences on wavelength were investigated experimentally. Some results showed the attenuation is originated from scattering and the other shows that that from a combination of scattering and absorption. This work was performed under the Cooperative Research Program of ‘Network Joint Research Center for Materials and Devices.’

## References

[1] S. Fukushima et al., ‘Infrared extinction of a dye-doped (polymer/liquid crystal) composite film,’ Crystals, vol. 5, pp. 163-171, 2015.