

Title:

Optical responses of bio-reflectors of aquatics under magnetic fields

Authors:

Masakazu Iwasaka^{1,2} and Yuri Mizukawa¹

Affiliations:

¹ Graduate School of Engineering, Chiba University, 1-33 Yayoicyo, Inage-ku, Chiba Japan

² Japan Science and Technology Agency, PRESTO, 4-1-8 Honcho, Kawaguchi 332-0012 Saitama, Japan

Aquatic living creatures such as fish are utilizing organic and inorganic crystals produced in the surface of their body for the purpose of controlling the sunshine reflections. In the case with fish scale guanine crystals, it was found that the thin plate-like crystals were generated in the iridophore cells on the body surface which was the similar process with the bio-mineralization process in the magneto-tactic bacteria. Our study revealed the very rapid response of the guanine crystals of goldfish scale by utilizing the dark field illumination under magnetic fields of up to 5 Tesla (T) [1,2]. The guanine crystals were separated from the iridopore cells in fish scales and suspended in an aqueous solution setting in an optical chamber for in-situ CCD microscope observation during the magnetic field exposures. Combining three kinds of vectors, magnetic fields, light incidence and observation provided a critical condition for the distinction of the light scattering inhibition and enhancement. The rapid change in the light scattering intensity was observed when the applied magnetic fields at 500 mT provided, and the mechanism was well explained the diamagnetic orientation of guanine crystal plates whose length, width and thickness were 20 μm , 5 μm and about 100 nm, respectively. Also it was observed that the Brownian motion of the guanine crystals under magnetic fields of up to 5 T was decelerated, and enhanced after switching off. XRD pattern analysis and AFM measurement indicated that the observed guanine crystals were mono-crystal plate primary containing of anhydrous guanine crystals and partially accompanying mono-hydrate guanine crystals. In addition to the distinct light scattering properties which can be applicable for biogenic micro-mirror devices, the mono-plate crystals showed a rapid magnetic bi-axial rotation at 300 mT order which was provided by a permanent magnet. The c-axis (width) of the crystal plate oriented parallel to the earth gravity when the magnetic fields were set parallel to the gravity [3]. On the other hand, the b-axis (length) oriented parallel to the horizontal

magnetic fields. It was suggested that the guanine crystals have diamagnetic torque energy which is comparable to the rotational kinetic energy. Furthermore, the developed measurement technique for detecting the micro-mirror light reflection was applied for exploring the similar biogenic crystals in cell-covering in algae cells.

References

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Web site

<http://www.tms.chiba-u.jp/~iwasaka/kaken.html>

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