Measurement and control of biological microcrystals by magnetic field and light

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In animal kingdom, there should be huge number of unrevealed functions of biological materials. Biochemical functions of these materials attracted many researchers and the results of research have already been provided to an industry. In contrast, physical properties, such as magnetic and optical property, of the biological materials are less clarified. One of the mechanism of magnetic field effects is magnetic orientation. The magnetic orientation can be observed in diamagnetic materials as well as strong magnetic materials. The required conditions for rotating the diamagnetic materials are distinct diamagnetic anisotropy and diamagnetic torque energy exceeding the thermal agitation in room temperature. Microcrystals are one of the candidates of dia-magnetically controllable target by utilizing a conventional magnetic fields (less than 500 mT).

At present, some kinds of biogenic microcrystals were found to be magnetic field responsible even though they did not contain effective amount of para- or strong- magnetic materials. A biogenic crystal containing guanine, which is produced in iridophore of fish skin, is biochemically designed to act as a ñbio-reflectorò, and it was revealed that the guanine crystals in many species of fish are distinctly responsible to the magnetic fields of more than 100 mT ~ 200 mT. The newly discovered light reflecting anisotropy in the guanine crystals enabled the detection of magnetic rotation [1]. Recently, as a kind of biomimetic approach, we are investigating guanine crystals in deep sea fishes, as shown in Fig. 1, those should have an effective light control mechanism which might be useful for our industry.

The guanine has relatively high reflective index (~1.8) and can obtain distinct diamagnetic anisotropy when they form a platelet. We can expect same kind of light reflecting control by magnetic fields in other type of biogenic crystal. For example, coccolith disk, a calcium carbonate crystal generated in the phytoplankton *E. huxleyi* oriented under the magnetic fields [2].

The introducing magnetic study on biogenic microcrystals can provide a new control method for tunable color control.

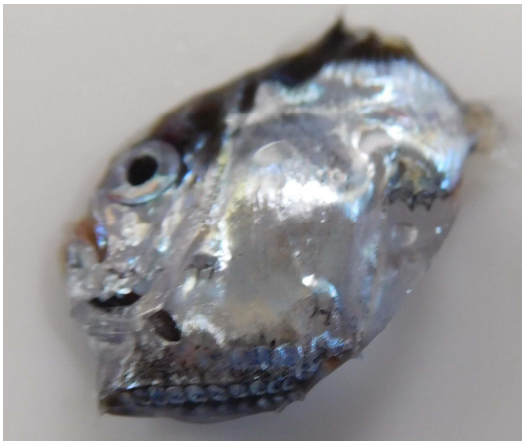

Fig. 1. Silver shining in a deep sea fish.

Reference

1) Magnetic control of the light reflection anisotropy in a biogenic micro-guanine crystal platelet, M. Iwasaka, Y Mizukawa, N Roberts, Langmuir, 2016 Jan 12;32(*1*):180-7. doi: 10.1021/acs.*langmuir*.5b03522.
2) Light intensity modulation by coccoliths of Emiliania huxleyi as a micro-photo-regulator, Y Mizukawa, Y Miyashita, M Satoh, Y Shiraiwa, M Iwasaka, Scientific reports 5, 13577 (2015); doi :10.1038/srep13577