

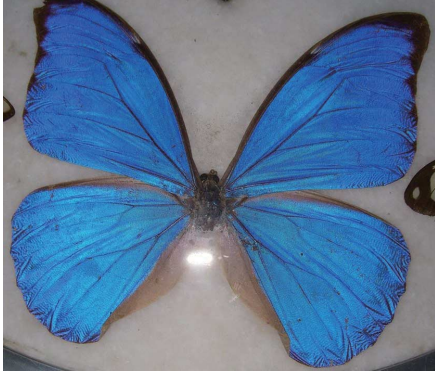
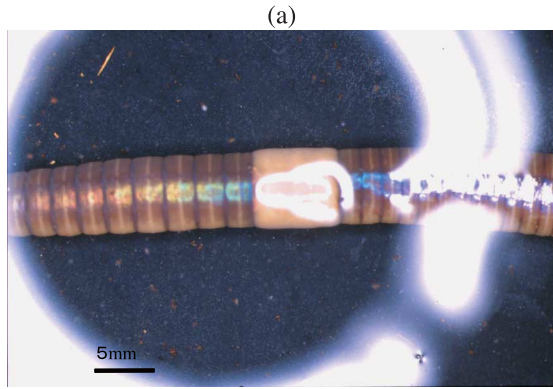
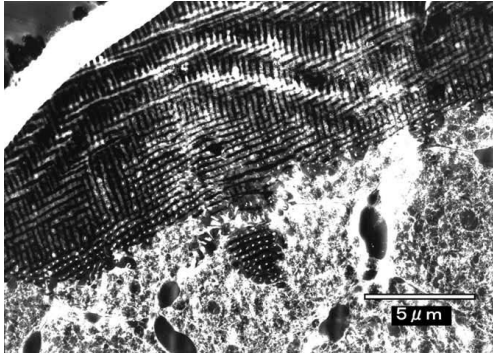


Fig. 1. Structural color of a morpho butterfly.



(a)



(b)

Fig. 2. (a) Structural color of an earthworm (*Metaphire communissima* (Goto and Hatai, 1899)). (b) A TEM image of a parallel section of the glass membrane of the earthworm. Both images are reproduced from (Kosaku and Miyamoto, 2002a).

Green function is extended for the case that scattering domains exist periodically in a system (Otani and Nishimura, 2008).

In the periodic FMM, a system which is finite in the direction stacking layers, i.e., x -direction, but infinite in the y - and z -directions is considered. The unit cell of the periodical structure in two directions of six layers in the water is defined as shown in Fig. 4.

By referring to table 1 of Miyamoto and Kosaku (2005), the values of the interval L of a fiber, the layer space H , and the diameter D of a fiber are estimated as $D = 165$ nm, $H = 185$ nm and $L = 225$ nm, respectively. The

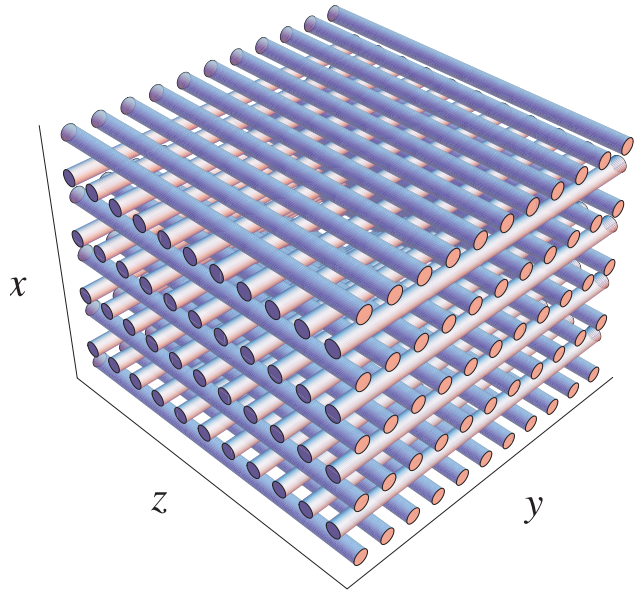


Fig. 3. A model of the epidermis of an earthworm, called a log-pile structure of fibers.

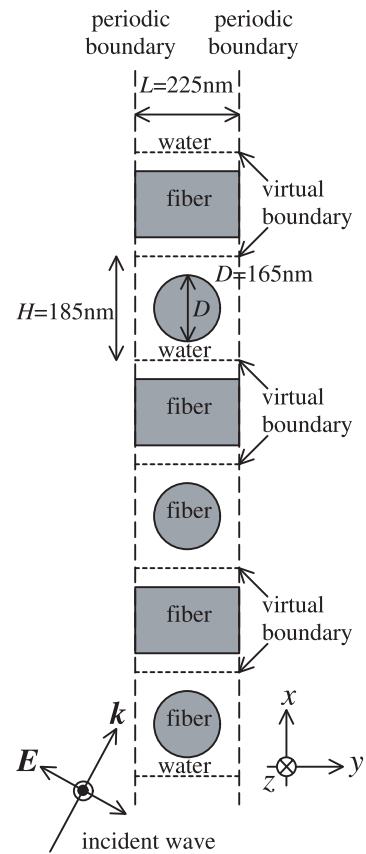


Fig. 4. The unit cell of the periodical structure in two directions of 6 layers in the water.

refractive index of water and the fiber is set to $n_1 = 1.33$ and $n_2 = 1.58$, respectively. The relative dielectric constant of water and the fiber are, then, $\epsilon_1 = 1.7689$ and $\epsilon_2 = 2.4964$, respectively, and both relative permeabilities are set to $\mu_1 = \mu_2 = 1$.