Temperature change induced spatial pattern formation in a cholesteric liquid crystal

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We report a spatial pattern formation process in a cholesteric liquid crystal, cholesteryl oleyl carbonate, which is induced by a rapid temperature change. This material shows very large temperature dependence of the pitch of the helical structure. Thus, it is expected that a rapid temperature change causes large frustration of the helical structure and produces structurally non-equilibrium conditions, which may trigger new behavior of this material. In fact, we have found that a peculiar spatial pattern formation occurs when the sample, sandwiched between two glass plates, is heated faster than 0.5 mK/s. The induced pattern is like a two-dimensional network and it consists of the round black parts in the size of several microns connected with each other by bold wires having the thickness in a similar size and the length of 10-20 microns. The network can be easily observed with an optical microscope since it has a different color from the other background part having the color produced by the selective reflection of the helical structure.

In addition to the microscopic observations, we have simultaneously measured the time-resolved transmission spectrum during the pattern formation process. It has been found that two additional components appear in the spectrum besides the original peak which is caused by the selective reflection in equilibrium state. One additional peak is located at a shorter wavelength than that of the original helical structure. The other component appears as a continuous background which gradually increases as wavelength decreases.

The phenomenon is a new example of the spatial pattern formation under non-equilibrium conditions. In this paper, we will report the detailed observation of this pattern formation process and discuss the mechanisms using a phenomenological model.