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Fluorescence from Pearls under N_2 Laser Excitation and Its Application to Distinction of Mother Oysters

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Fluorescence spectra of pearls of *Pinctada fucata* (Japan's Akoya oyster) and *Pinctada maxima* (white lip oyster) have been measured in order to distinguish species of the mother oyster which produce that pearl. A distinction is possible for these pearls using the difference in the fluorescence spectra under N_2 laser excitation.

Kokichi Mikimoto succeeded in inventing a technique for pearl culturing using *Pinctada fucata* (Japan's Akoya Oyster) in 1893. Since then, cultured pearls have been produced from shellfish; it is now the most famous mother oyster in the pearl culture business. However, several mother oysters are also used in pearl culturing: seawater bivalves; *Pinctada maxima* (white lip oyster), *Pinctada margaritifera* (black lip oyster), *Pteria penguin* (mabe); seawater gastropod; genus *Haliotis* (abalone); freshwater bivalve; *Hyriopsis shlegeli* et al.

By examining the pearl itself, it is possible to distinguish various species of the mother oyster which produce that pearl. Nondestructive methods for distinguishing mother oysters have been important from practical points of view since the commercial value of pearls depends on the mother oysters. In summary, freshwater pearls can be distinguished from seawater pearls by using an X-ray fluorescence analysis since freshwater pearls contain a large amount of manganese.[1)] Pearls of *P. margaritifera* show a peculiar absorption at 700 nm.[2)] Pearls of genus *Haliotis* can be distinguished from pearls produced from any other mother oysters under a microscope since the surface of gastropod nacre shows a pyramid stack formation.[3)] Here, nacre is the surface layer part of pearl and shell.

On the other hand, as far as we know, there has been no report on the distinction of mother oysters for *P. fucata*, *P. maxima* and *P. penguin*. In this paper, we have measured the fluorescence spectra of pearls of *P. fucata* and *P. maxima* under N_2 laser excitation in order to apply the fluorescence method to the distinction for these pearls. The laser-induced fluorescence method has already been applied for the identification of pigments in oil colours[4)] and of natural dyes in textile fabrics.[5)] This method is more sensitive than the ordinary fluorescence method.

The laser-induced fluorescence has been measured at room temperature with the apparatus described in ref. 4. The excitation source was a pulsed N_2 laser (λ = 337.1 nm, pulse duration = 5 ns, repetition rate = 4 Hz). The peak intensity of the laser light on a sample was about 100 kW/cm^2. Time-integrated fluorescence spectra were measured with a 50-cm monochromator, a photomultiplier (Hamamatsu R955), a boxcar integrator and a recorder.

The materials in this study were pearls of *P. fucata* and *P. maxima*. Mother oysters of

P. fucata produce some colours of pearls; white, green, pink, yellow and blue. In these colours, green and pink appearances were caused by an interference effect in nacre, while yellow and blue appearances are considered to be due to organic substances in the pearls. Mother oysters of *P. maxima* produce white and yellow pearls. The yellow appearance is also considered to be due to organic substances. Consequently, white and yellow pearls of these two species have been investigated in order to examine the relation between the colour appearance and the fluorescence spectra. About five pearls were examined for respective colours and species. Some of the pearls to be investigated were irradiated with Co-60 γ-rays at room temperature. The irradiation dose was about 10^7 R.

Figure 1 shows fluorescence spectra of white pearls of *P. fucata* (solid curve) and *P. maxima* (dashed curve). The peak wavelength was about 460 nm for *P. fucata* and about 440 nm for *P. maxima*. Since the peak wavelength for *P. fucata* is longer than that for *P. maxima*, a distinction is possible by using the difference. However, the peak wavelength may depend on the colour appearance of pearls. The peak wavelength is measured for white and yellow pearls of *P. fucata* and *P. maxima* in order to examine this dependence. Figure 2 shows the peak-wavelength distribution for these pearls of *P. fucata* (solid lines) and *P. maxima* (dashed lines). For white pearls, the peak wavelength for *P. maxima* is 440-450 nm, while that for *P. fucata* is 460-480 nm. Since the peak wavelength for *P. maxima* is not overlapped by that for *P. fucata*, a distinction is possible for white pearls. Also, no overlapping of peak wavelengths was observed for yellow pearls. Thus, a distinction is possible for any colour appearance of pearls.

Pearls are usually processed for improving their commercial value. Figure 3 shows the fluorescence spectra for γ-ray irradiated pearls of *P. fucata* and *P. maxima*. Fluorescence at the long-wavelength region decreases with γ-ray irradiation. Similar spectra to Fig. 3 were observed for pearls treated with other processes, such as bleaching and heating. It is difficult, therefore, to distinguish the processed pearls using the fluorescence method. It has been reported that γ-ray irradiation causes a degenenation of conchiolin,[6] which is a kind of scleroprotain in pearls and shells. Thus, it is considered that the difference in conchiolin causes the spectral difference observed in unprocessed pearls of *P. fucata* and *P. maxima*.

In summary, fluorescence spectra of pearls of mother oysters have been measured under N_2 laser excitation. Distinction is possible for pearls of *P. fucata* and *P. maxima* using the difference in the fluorescence spectra. To the contrary, a distinction is difficult for processed pearls.

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Figure captions

Fig. 1. Fluorescence spectra of white pearls of *P. fucata* (solid curve) and *P. maxima* (dashed curve). Peak intensities are normalized.

Fig. 2. Distribution of the peak wavelengths of fluorescence from white and yellow pearls of *P. fucuta* (solid lines) and *P. maxima* (dashed lines).

Fig. 3. Fluorescence spectra of γ-ray irradiated pearls of *P. fucata* (solid curve) and *P. maxima* (dashed curve). Peak intensities are normalized.

Fig. 1

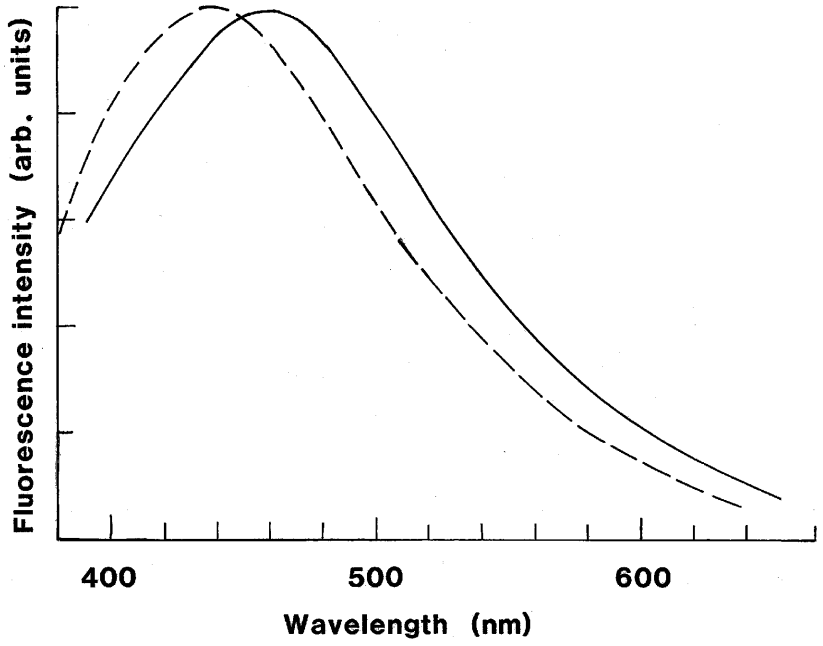

Fig. 2

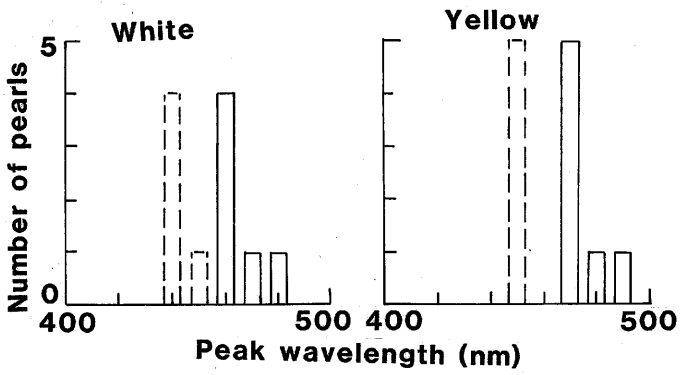

Fig. 3