Analytical and enviromental chemical studies on microplastics in Osaka Bay

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In recent years, marine plastic has attracted attention as a new environmental problem. On the other hand, plastic components are considered to be safe because they are unlikely to directly affect living organisms. However, if marine organisms accidentally ingest microplastics (<5 mm), there is a concern that physical obstruction or damage to eating organs and gastrointestinal tract may occur. In addition, there is a concern that harmful substances adsorbed on microplastics may adversely affect the human body by the food chain. However, there are few studies on the dynamics of the ultrafine microplastics in Japan.The purpose of this study was to elucidate the concentration, type and source of microplastics in Osaka Bay.

Experimental

Sampling

The surface seawater was pumped with a seawater pump (120 L / min). The pumped seawater passed through a stainless steel sieve with a mesh size of 5 mm, and then passed through a plankton net with a particle size of 100 μm. The sample include microplastics with a particle size of 100 μm to 5.00 mm were collected on a plankton net. Seawater (100 L) that passed through the plankton net was also collected in a polyethylene tank and brought back to the laboratory. This seawater sample was used for the detection of MP with a particle size of <100 μm.

Qualitative evaluation of microplastics

The qualitative evaluation of microplastics in the sample was performed using a scanning electron microscope (Hitachi High-Technologies Corporation, high-resolution field emission scanning electron microscope (FE-SEM) S4800) and a Fourier transform infrared spectrophotometer (Jasco FT-IR6100).

Separation of microplastics by density

The collected sample on the plankton net contain various substances such as microplastics, phytoplankton, wood chips, and sand. The separation was carried out by density difference using NaI (density of 1.6 g cm-3), because the density of a commercially available plastic is 0.9 to 1.6 (g cm-3).

Separation of microplastics using mixed acid decomposition.

Even in the separation method using the density difference, organic compounds such as phytoplankton and wood chips may remain in the sample. Decomposition methods with acids, alkalis, oxidants, enzymes, etc. may be able to decompose the remaining organic compounds in the sample. In a previous study, a decomposition method using H2O2 as an oxidizing agent was examined for the sample which collected in Osaka Bay. SEM-EDX analysis confirmed biological fragments likely to be diatoms in the sample after decomposition. The biological fragments was still remained by decomposition with potassium hydroxide (10%), nitric acid, and hydrofluoric acid. It was found that the decomposition by these reagents was insufficient.Therefore, the decomposition method using a mixed acid of nitric acid, perchloric acid, and hydrofluoric acid was investigated for decomposing biological samples. As a result, it was confirmed that phytoplankton samples could be almost decomposed.

Effect of acid decomposition on plastic
A resistance experiment for plastic sample was performed by using nitric acid + perchloric acid + hydrofluoric acid. As shown in Table 1, discoloration was observed in some plastic samples, but no structural change was observed from FT-IR results.

Microplastics in seawater samples collected in Osaka Bay
The IR spectra of a sample collected in Osaka Bay, commercial high-density polyethylene (HDPE), and commercial polypropylene (PP) were shown in Fig.1. From this result, it was found that HDPE was contained in the sample collected in Osaka Bay.

Keywords: Microplastics, Osaka Bay, Analytical chemistry, Environmental chemistry

Table 1 Polymer change by nitric acid + perchloric acid + hydrofluoric acid

Polymer	Recovery rate (%)	Polymer degration	Color change
PE	99.7	No	No
HDPE	100	No	Brown change
LDPE	100	No	No
PS	100	No	Brown change
HIPS	98.3	No	Yellow change
PET	96.4	Deterioration	No
PP	99.9	No	No
PVC	98.8	No	White change
PTU	n.a	Melting	Yellow change
Nylon6	n.a	Melting	Yellow change
Nylon6,6	n.a	Melting	Yellow change
PA6	n.a	Melting	Yellow change
GPPS (Crude oil naphtha)	98.8	No	Yellow change
Gasoline tank (Light oil / crude oil	100	No	No
Regenerating agent (PPS resin)	100	No	No
Solvent (acrylic resin)	100	No	No

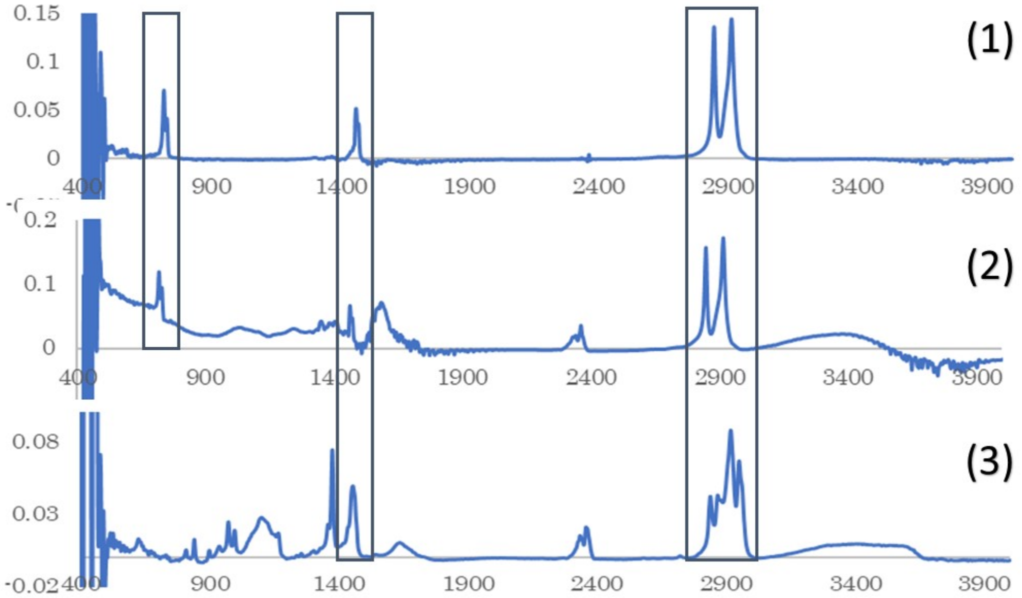

Fig. 1 FT-IR spectra of sample collected from Osaka Bay, HDPE, PP

(1) Osaka Bay, (2) HDPE, (3) PP