

Electronic Supplementary Information (ESI) for Analytical Methods

Identification of black microplastics using long-wavelength infrared hyperspectral imaging with imaging-type two-dimensional Fourier spectroscopy

Kosuke Nogo,^a Kou Ikejima,^b Wei Qi,^a Natsumi Kawashima,^a Tomoya Kitazaki,^a Satoru Adachi,^a Kenji Wada,^c Akira Nishiyama,^c and Ichiro Ishimaru^{*a}

a. Faculty of Engineering, Kagawa University, 2217-20 Hayashi-cho, Takamatsu, Kagawa 761-0396, Japan.

b. Faculty of Agriculture and Marine Science, Kochi University, 200 Otsu, Monobe, Nangoku, Kochi 783-8502, Japan.

c. Faculty of Medicine, Kagawa University, 1750-1 Miki-cho, Kita, Kagawa 761-0793, Japan.

**Corresponding author. E-mail: ishmaru.ichiro@kagawa-u.ac.jp*

S1 Plastic samples

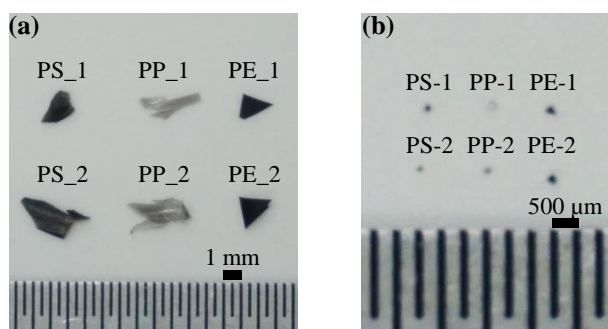


Fig. S1 (a) Black plastic specimens cut from the black plastic products shown in Fig. 4 (a). (b) Black microplastics cut from the black plastic specimens shown in Fig. S1 (a).



Fig. S2 White plastic products.

S2 Procedure for the angle of view correction

Step 1. SpectroCapture software (NISSIN KIKAI Co., Ltd., Kagawa, Japan) was used to measure the spectrum. As recommended, we used a bandpass filter (central wavelength: 10,240 nm, full width at half maximum: 663 nm).

Step 2. The image file for the interferogram acquired in step 1 was loaded in SpectroViewer (NISSIN KIKAI Co., Ltd.). Next, the window function and number of data points in the FFT were selected, the sampling interval was entered, and the Fourier transform was performed.

Step 3. Using a function that allowed you to register the pixels you wanted to display spectra for, we registered a pixel in the center of the image, a pixel located about 10 pixels from the left edge, and a pixel located about 10 pixels from the right edge (e.g., Fig. S3). The spectra of these pixels without correction are shown in Fig. S4 (a).

Step 4. The parameter setting screen was opened for angle of view correction. The following parameters were entered: (A) the length of one side of the FPA pixel used (12 μm), (B) the focal length of the lens in front of and behind the mirror (17 mm), (C) the setting angle of the mirror to the incident beam of light (45°), and the central pixel of the acquired image ((D) 160 pixels in the horizontal direction, (E) 128 pixels in the vertical direction) (Fig. S5 (a)). Next, the display was updated. With these settings, the peak positioning was still off as shown in Fig. S4 (b).

Step 5. If there was a wavelength shift in the spectra of three pixels in step 4, the parameter setting screen for angle of view correction was opened again. First, the mirror installation angle was determined by changing the mirror installation angle and updating the display so that the position of the peak or dip in the spectrum of the central pixel was located at the correct position. Next, the value of the lens focal length was set so that the spectra of the left and right pixels overlapped with the spectrum of the central pixel. The above process completed the correction. If the spectrometer did not need to be dropped to displace the mirror or the lens, this process only needed to be performed once and the correction parameters set in the above process were recorded in the software. In our experiments we used the following settings: (A) 12 μm , (B) 15.8 mm, (C) 44.9°, (D) 160 pixels, and (E) 128 pixels (Fig. S5 (b)). The results obtained after Step 5 are shown in Fig. S4 (c).

(a) 画面補正のパラメータ設定

(A) 画素ピッチ 12.000 [um]

(B) レンズ焦点距離 17.000 [mm]

(C) ミラー実角度 45.000 [°]

(D) 中心座標:X 160 [pixel]

(E) 中心座標:Y 128 [pixel]

(b) 画面補正のパラメータ設定

(A) 画素ピッチ 12.000 [um]

(B) レンズ焦点距離 15.800 [mm]

(C) ミラー実角度 44.900 [°]

(D) 中心座標:X 160 [pixel]

(E) 中心座標:Y 128 [pixel]

Fig. S5 The parameter setting screen for the angle of view correction showing the settings for (a) step 4 and (b) step 5.

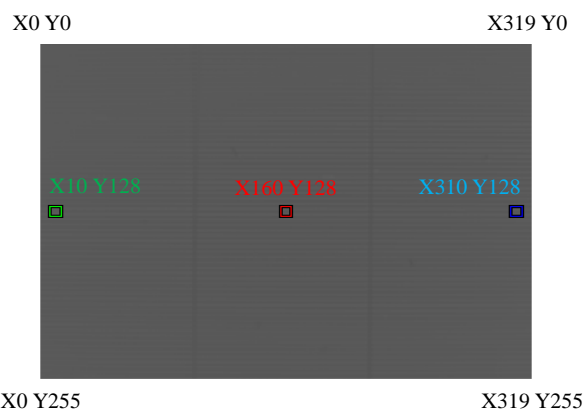


Fig. S3 Example of pixel specifications for determining the correction parameters.

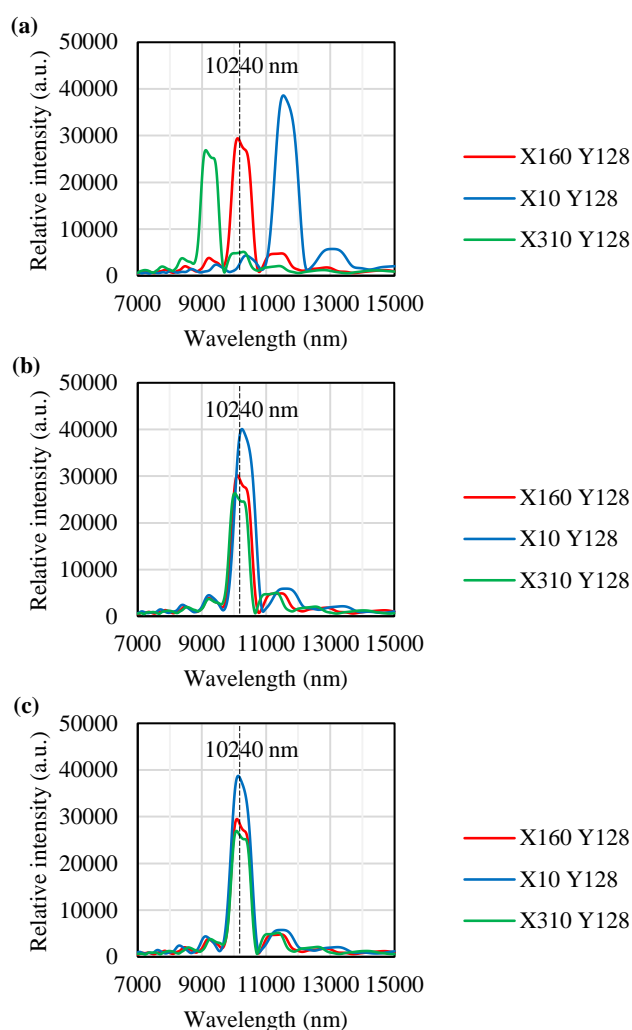


Fig. S4 Spectra recorded with a bandpass filter (central wavelength: 10,240 nm, full width at half maximum: 663 nm). Each spectrum is an average of the data for 11 \times 11 pixels centered on the corresponding pixel shown in S-Fig. 1

S3 Absorbance spectra with different average numbers of pixels

The software SpectroViewer (NISSIN KIKAI Co., Ltd., Kagawa, Japan) was used to average the spectra of $n \times n$ neighboring pixels centered on the pixel of interest. The effect of this function was confirmed by altering the number of pixels to be averaged, and the results are shown below.

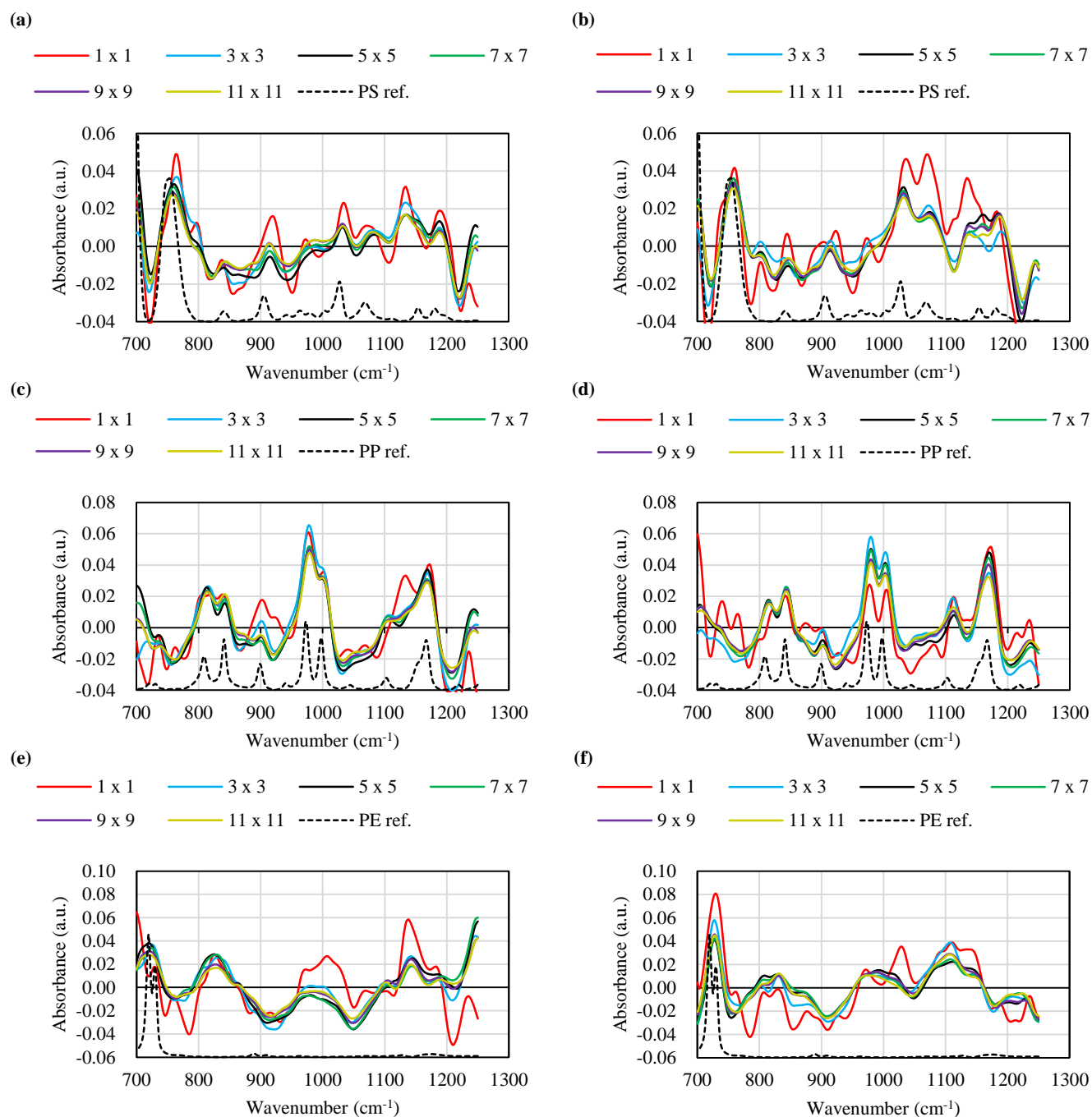


Fig. S6 Absorbance results for black MPs in Fig. 5 for different average numbers of pixels. (a) PS-1, (b) PS-2, (c) PP-1, (d) PP-2, (e) PE-1, and (f) PE-2.