# Detection of microplastics less than 330 μm using μFTIR

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A total of 150 million tons of plastic waste has accumulated in the oceans. Presently, eight million tons per year of plastic waste flow into the oceans as marine debris. However, the amount of identified plastic waste is below 1 % of the total plastic waste (e.g., 0.44 million tons) and the remaining 99% is undetected. Unidentified plastics referred to as missing plastics are not observed as they sink to the ocean bottom and/or break down into small pieces called microplastics (MPs) (e.g., MPs with maximum lengths less than 5 mm). MPs larger than 330 μm have been detected. However, no widespread observation methods or measurement protocols exist for MPs smaller than 330 μm that are considered to be more influential particles for ecosystems. Therefore, in this report, we introduce new protocols for detecting MPs having less than 330 μm.

The water samples were collected by T/V Shinyo-Maru of Tokyo University Marine Science and Technology in July 2019. We use two systems for sampling; 1) Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS); and 2) large capacity pump. In the case of MOCNESS, we used a 64 μm mesh net, although a 330 μm mesh net is typically used. MOCNESS was opened and closed in each layer up to 1000 m depth, and filtered particles from seawater of several hundred $m^3$ from a volume of several tens. For the pump system, we collected 20 L of each layer (maximum is 50 m) in to a 7 μm mesh plankton net.

The collected net samples were extracted so that the volume after reduction was 0.1 $m^3$ because a few hundred $m^3$ of sea water was concentrated in the sample. For the pump samples, the number of smaller particles should be greater than the number of net samples, and we used a volume after the reduction of 0.01 $m^3$. After extracting the seawater, we added a 30 % $H_2O_2$ and 0.05M Fe (2) solution and the samples were then heated to 60 ˚C to eliminate the contaminants. After two weeks, density separation was conducted by adding NaI to the sample to adjust the specific gravity to 1.5. The candidate particles in the supernatant were collected by a PTFE filter using vacuum filtration. The filters were dried overnight. The infrared spectra of the candidates measured using micro Fourier transform infrared spectroscopy (IR/T-7200 of JASCO Inc., Japan). The measured spectra were compared with stored plastic spectra. A color image map of the correlation coefficients was converted into a bicolor figure to determine the particle sizes using the imaging software.

We focused on the polyethylene and polypropylene particles that were smaller than 330 μm. A sample collected by the pump system showed concentrations of a few million particles/$m^3$ at the surface and showed concentrations of a few thousand particles/$m^3$ at 50 m depth. These concentrations are several thousand times greater than those obtained in the surface layer using the Neuston net (330 μm); Previous observation and measurement protocols would underestimate the amount of MPs.

Keywords: microplastics, μFTIR

 