ABSTRACT

Every year, a huge quantity of marine debris is washed up onto Japanese coastal areas, and more than half of the debris is plastic. It has been thought that plastics such as polystyrene or polycarbonate do not thermally decompose at a natural environment temperature. However, a possibility that polystyrene is decomposed at a low temperature of 30 to 50 °C, such as a temperate or a subtropical beach condition, was pointed out. When polystyrene decomposes styrene oligomers are produced. The authors have carried out field investigations on Japanese beaches from 2007 to 2012 in order to understand the pollution situation of Japanese coastal areas. In this paper, we report the field investigations and laboratory analyses. High abundances of marine debris were found on Japanese beaches with limited access roads. The styrene oligomers were detected from all beach sand and shore water samples. Averages of styrene oligomers of the sand and the water are 470 μg/kg and 3.1 μg/L, respectively.

KEY WORDS: Marine debris; plastic; chemical substance; contamination; coastal area; field investigation; styrene oligomers.

INTRODUCTION

Plastic is a useful material in our life, and every year, more than 200 million tons of plastic are manufactured in the world. Most of the used plastic is disposed of properly or recycled. However, a part of the used plastic is thrown away into the nature intentionally or carelessly, and they cause a burden to the environment. Annually, about 150,000 tons of marine debris is cast ashore onto Japanese coastal areas, and more than half of the garbage is plastic. The marine debris plastic causes accidental ingestion by marine organisms and/or getting the beaches dirty, worsening the scenery and giving heavy damage to the fishing and the tourist industry.

It has been believed that plastic does not decompose thermally at the temperature of our daily life. However, Saido and Taguchi (2003) and Saido and Kodera (2005) pointed out that polystyrene or polycarbonates are thermally decomposed slowly under a low temperature of 30 to 50°C. And furthermore, Sato and Saido (2009) reported that styrene oligomers, which are decomposed products of polystyrene, were detected by GC-MS analysis for beach sand and shore water samples of the Tokyo Bay area. Styrene monomers, generated from polystyrene, are declared as a carcinogenic substance by IARC (International Agency for Research on Cancer). Bisphenol A produced from polycarbonate or epoxy resin, is well known as an endocrine-disrupting chemical, similar to phthalate ester generated from polyvinyl chloride or polyethylene terephthalate. If harmful chemical contamination is generated from thermal decomposition of plastic on the shore points, impacts on ocean organism and human beings are expected. When the environmental preservation materializes, not only bulky plastics but also chemical contamination should be reduced. Therefore, we need to understand the pollution conditions of the coastal areas and the ocean in order to discuss the reduction processes.

We have been collecting samples of beach sand and shore water at 185 Japanese coast sites, and performing the GC-MS (Gas Chromatography and Mass Spectrometry) analyses (Iwai and Sato (2009), Amamiya and Sato (2010), Nishino and Sato (2011)). In this paper, we focus on styrene oligomers (SO) comprising styrene monomer (SM), styrene dimer (SD) and styrene trimer (ST). The chemical analyses results are reported and the pollution condition of Japanese coastal areas is discussed.