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Session 3: Environmental Applications in Spectroscopy

EAS 3.1 Monitoring Plastic Waste Using FTIR Spectroscopy

Albert van Oyen[a], Jan Andries van Franeker[b], Uwe Oppermann[c], Marion Egelkraut-Holtus[c]

[a] *Research, Harderhook 20, D-1432 Bocholt, CARAT GmbH, Germany*
[b] *Research, PO Box 167, 1790 AD Den Burg Texel, IMARES, Netherlands*
[c] *Spectroscopy, Albert- Hahn- Str. 6-10, D-47269 Duisburg, Shimadzu Europa GmbH*

The production of plastic has reached an all-time high, for instance in 2012 there has been 288 million ton (MT) produced worldwide[1]. According to the United Nations Environment Program it is estimated that annually 6.4 Mt plastic ends in our seas and oceans worldwide. Estimates of the total volume in our oceans exceed more than 100 Mt [2] but more and more research assumes this is an underestimation.

In the environment degradation of plastic takes place. Under influence of UV-radiation and the ocean waves, big pieces of plastic are grinded into microplastics (< 5 mm). A large amount of these plastics will wash up the beaches where the sand is abrasive. The sand stores a lot of heat and exchanges this with the plastics, which accelerates the degradation.

An FTIR spectrum of a Polyethylene (PE) fragment in the environment differs strongly from the virgin state of PE as it was produced. The result of degradation are lot of new peaks. At this time, it's a well adopted opinion that degradation of PE mainly takes place on the surface. The plastic fragments on beaches getting sanded and small pieces released of the surface, are forming an invisible pollution. The plastic soup is becoming a plastic bouillon. Experimental work is in progress for analyzing the micro particles.

Marine biota mistakes plastic for food. Well known are the pictures of Chris Jordan [3] of albatross chicks which died of hunger but having a stomach full of plastics. Nowadays more and more researches are concentrating on the stomach content of fish and birds. About 95% of the North sea fulmars have plastic in their stomach. In the 1980s about half of these ingested plastic were industrial pellets, but nowadays 80% by mass is consumer waste, mostly PE.

For interpretation of FTIR spectra currently the majority of the polymer- or plastic libraries are using spectra of prime materials and are very useful for prime materials, polymer production waste, pre-consumer recyclates but insufficient for post consumers recyclates and plastic found in the environment.

Plastics are not inert but change over time as they are thermodynamically metastable. Plastics are losing their preferred and desired mechanical and thermal properties. Therefor the plastic recycle market is limited by the thermo dynamical state of the wasted plastics. The identification of plastic in our environment needs an updated determining method.

FTIR-ATR is a strong tool for identifying plastic over a long period of time, or even better over a degradation period. With the right library, FTIR-ATR is a helpful tool for polymer industry as well as for pre- and post- consumer plastic waste recycler, and for the researchers who are describing the plastic waste in our environment.

Keywords: FTIR-ATR Spectroscopy; Plastic; Environment, Wildlife

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