3D Computed Tomography for Microplastics Analysis

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Introduction: Microplastics pollution is one of the newer marine environmental problems since it has been confirmed to have a detrimental effect on marine ecosystems [1]. All plastics from the sea are considered to end up in sediments, even those lighter than sea density of 1.02 g/cm^3. This is due to changes in the density of microplastic particles with time such as the biofilm fouling. Microplastics are ubiquitous in the marine environment and are found even in sediment at depths greater than 5000 m. More than 2000 microplastic particles/m^2 were found in the deep-sea sediment [1,2], while on beaches near the urban centers the number of microplastic particles can rise up to 285,000 [1].

Methods: A number of different methods can be found in the literature [1] depending on whether the composition or amount of plastic particles is determined. The most common approach is by using the microscope aided visual inspection. The Fourier-transform infrared spectroscopy (FTIR) is considered the most reliable method to identify the chemical composition of microplastics [3]. However, all methods currently in use include pretreatment of the sediment sample by extraction which prolongs analysis time and requires a significant effort of the researcher. Here we propose for the first time the use of 3D ComputedTomography (3DCT) to investigate microplastics in marine sediment. 3DCT is a non-destructive method that allows a rapid examination of the sample with respect to different particle densities with sub-millimeter resolution. The resolution for smaller samples can go down to 1 μm. The density of plastics is much lower than the density of sediments and shell remains. Most plastic particles have a density of 0.89-1.58 g/cm^3 [3,4], while the typical density for sand and other sediments is 2.65 g/cm^3 [3]. The density of calcite and aragonite is 2.711 and 2.83 g/cm^3, respectively.

In this research, we will use the CT scanner NIKON XTH 225. The first step will be to calibrate the system with standard matrices in order to be able to determine with certainty the density and size of various plastic micro-particles found in the sea sediments.

Discussion: The development of the 3DCT method is currently in progress. The analysis is planned both in bulk and core sediment samples. The major advantage of the method is a non-destructive, rapid, and precise analysis of microplastics. The method can potentially lower the current minimum size of plastic micro-particles from 20 μm (by using FTIR spectroscopy) to 1 μm. The basic statistic analysis can be automatically performed. In addition, the 3DCT analysis can be applied to the core samples and the results can be put in the time perspective in the case of the intact sediment cores. This can help in identifying potential sources and pathways of microplastics pollution.

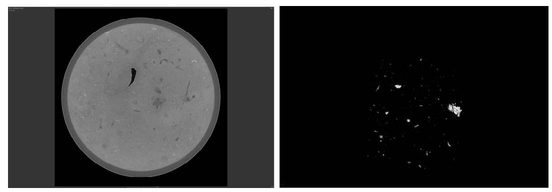

Figure 1. 3DCT images of a sediment core obtained by NIKON XTH 225. The picture on the right shows the remains of shellfish shells obtained by selecting the specific density.

According to the Guidance on Monitoring of Marine Litter in European Seas [3], currently there is a lack of QA/QC measures in the field of microplastics analysis. That is, there are no organizations yet to offer proficiency training or testing, there have been no inter-laboratory studies, no certified reference materials are available, no standardized sampling and analysis protocols have been published, no accreditation certificates have been issued and some procedures of use have not yet been validated. The aid of the new, verifiable methods such as 3DCT will be crucial for the development of the field.

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References:

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