SUCCESS STORY

microONE
Microplastic Particles: A Hazard for Human Health

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Module

Project:
Preparation – Detection - Analysis
01/2022-12/2025

MAKING THE INVISIBLE VISIBLE – TRACING NANO- AND MICROPLASTICS IN HUMANS

PLASTIC PARTICLES IN THE HUMAN BODY POSE A POTENTIAL RISK. THROUGH THE ANALYSIS OF IMAGES THAT CONTAIN CHEMICAL INFORMATION, THEIR EXACT POSITION CAN BE DETERMINED. THIS MAKES IT POSSIBLE TO GAIN A DEEPER UNDERSTANDING OF THEIR IMPACTS ON TISSUE AND HUMAN HEALTH.

Researchers from the COMET module microONE are developing a method to detect nano- and microplastics (NMP) through segmentation or division of image regions in microscopic images of complex samples, such as biological tissue. These approaches pave the way for studying the effects of NMP on human health. Advanced segmentation techniques enable precise and efficient localization and quantification of NMP by using chemical image data obtained through non-destructive "optical photothermal IR spectroscopy" (OPTIR) to organize image regions. The key challenge lies in combining high spatial resolution with advanced algorithms to overcome the traditional limitations of optical technologies.

Segmentation for Precise Analysis

Based on the chemical signals of the OPTIR measurement, segmentation accurately identifies microplastics within the tissue. This process divides the image into distinct regions to specifically detect microplastic particles and differentiate them from the surrounding tissue structures. Chemical imaging, in combination with segmentation algorithms, aims to contribute to a better understanding of potential health impacts of microplastics. Histopathological examinations can, for example, determine whether there are signs of inflammation or tissue damage in the affected areas, or whether the particles are only taken up by specific cell types.

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
Republic of Austria
Digital and Economic Affairs

Version 01/2020

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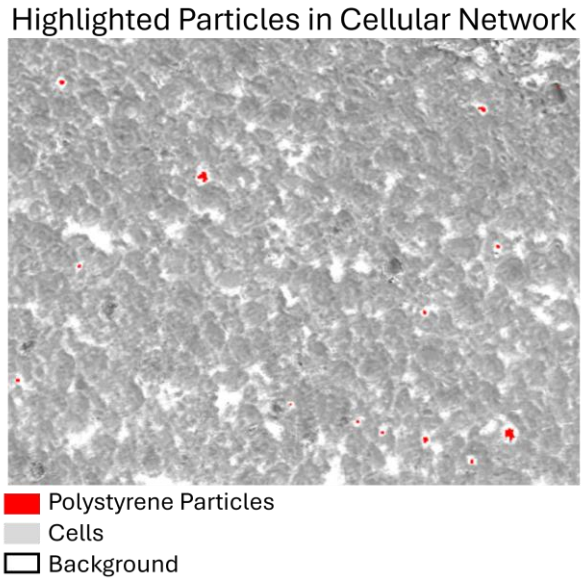
Localization of Nano- and Microplastics in Cellular Tissues

The image below shows an overlay of a light microscope image and a segmented image. Only the red pixels are displayed, corresponding to locations where a spectroscopic signal for polystyrene was detected. All other signals are displayed as transparent, allowing the underlying image to remain visible. This overlay provides a precise visualization of the positions of the particles. The segmentation process is based on a Gaussian Mixture Model (GMM), which distinguishes different regions in the image based on probabilities, reliably identifying the exact locations of the particles.



Overlay of Light-Microscope Image and Segmented Data: Red pixels indicate the exact position of the polystyrene particles, while the surrounding cells are clearly visible. © RECENDT GmbH

Extension of Application Areas and Outlook on Future Research Approaches

The use of segmentation methods in the microONE project allows for the precise localization and distribution analysis of even the smallest particles within the tissue. Efforts are currently in progress to refine the method further, particularly for complex tissue structures, to reliably capture also finest details. This advancement enhances our understanding of the interactions between particles and surrounding cells, as well as their exact positions within the tissue. Such in-depth knowledge of the mechanisms and impacts of these particles is crucial for evaluating their biochemical effects and potential health risks comprehensively. This success story highlights how innovative technologies help to investigate the effects of these particles on the human body while providing the basis for informed public health and sustainability strategies.

Project coordination (Story)

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This success story was provided by the CBmed GmbH and by the mentioned project partners for the purpose of being published on the FFG website.
microONE is a COMET-Modul within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, SFG (Styria) and WAW (Vienna). The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet