MSE Conference 2026, Darmstadt, 29.09-01.10.2026

Date, Time	Lecture Number	Projekt & Speaker	Session (Host), Place
01.10.2026, 10:40	Lecture #828	C01 Max Friedel	Session B02.1 (*Lee-Thedieck, Ciardelli*) S1I01 - A02
01.10.2026, 11:10	Lecture #922:	S01 Henri Berntgen	Session B02.1 (*Lee-Thedieck, Ciardelli*) S1I01 - A02
01.10.2026, 13.25	**KeyNote Lecture #169**	A04 Prof. Dr. Holger Kress	Session B02.2 (*Bronco & Vozzi*) S1I01 - A02
01.10.2026, 14:40	Lecture #254	A03 Jan Bollmann	Session B02.2 (*Bronco & Vozzi*) S1I01 - A02

01.10.2026, 10:40 AM Lecture #828

Session B02.1: Plastic Aging, Fragmentation, and Safe-by-Design Materials (Lee-Thedieck, Ciardelli)

C01 Max Friedel

From Films to Fragments: Decoding Polypropylene Photo-Degradation

Polypropylene (PP) films are widely used for packaging thanks to their excellent mechanical properties and low cost. However, they are not photostable, which causes them to degrade rapidly when exposed to UV light, leading to microplastic fragmentation. This study systematically investigates the effects of stabilisers (0.02 wt.% Irganox 1076, 0.02 wt.% Irgafos 168 and 0.08 wt.% Tinuvin 783) on single-layer and dual-layer PP films during accelerated weathering for up to 1000 hours, in accordance with ISO 4892-2:2013-06.

Films with an average thickness of 62 µm were produced by industrial blow extrusion using a PP homopolymer. Four configurations were tested: 1Layer_Neat, 1Layer_Additivated, 2Layer_NSW (neat side weathered) and 2Layer_ASW (additivated side weathered). A comprehensive, multi-method approach was used to monitor degradation and degradation products. ATR-FTIR was used to quantify the carbonyl and hydroxy indices and the relative surface crystallinity. DSC measured the melting temperature (Tm), bulk crystallinity (Xc) and lamellar thickness and distribution. SEM visualised the three-stage cracking process, while EDX mapped the depth profiles of oxidation across cross-sections. HT-GPC and DNP-NMR analyses are ongoing and nearing completion.

The key results revealed three phases of degradation: hydroperoxide accumulation; an autocatalytic rise in carbonyls; and, finally, microplastic fragmentation. Unstabilised films exhibited a short induction time, pronounced lamellar thinning, an increase in Xc and a decrease in Tm. The addition of stabilisers provided significantly greater protection against UV degradation, as demonstrated by an increase in induction time and more stable Xc and Tm values. However, the use of two-layer systems complicated the explanatory models. The alignment of the additive layer in relation to irradiation has been shown to affect the entire film. Combined with other methods, EDX enabled a four-zone oxidation model to be established for dual-layer films.

Our work expands the range of analytical tools available for plastic films by combining them into a comprehensive, explanatory approach that can be used to analyse increasingly complex multilayer films. This helps us achieve our goal of fully understanding the formation of microplastics from plastic films and address their risks.

01.10.2026, 11:10 AM #922

Session B02.1: Plastic Aging, Fragmentation, and Safe-by-Design Materials (Lee-Thedieck, Ciardelli)

S01 Henri Bertgen, Panda, S.K.; Kuenneth, C.

Machine Learning for Predicting Microplastics Hazard

Microplastics toxicity assessment remains fundamentally limited by data scarcity and reliance on monomer-proxy hazard classifications that ignore polymer-specific properties and environmental transformation. We present a computational framework combining transfer learning and polymer informatics to predict microplastics toxicity directly from chemical structure. Our ML pipeline, built on transformer-based polymer representations, was first trained on Tox21 molecular toxicity data. We then transferred this foundation to the polymer domain through fine-tuning on a separate polymer toxicity dataset. This strategy demonstrates that molecular toxicity knowledge can

be successfully transferred to polymer hazard prediction, overcoming severe data limitations in polymer toxicology. Building on this validated strategy, we outline two integrated research directions: (i) coupling toxicity forecasts with environmental degradation pathways - photodegradation, hydrolysis, enzymatic transformation - to model how particle structure and hazard evolve across environmental compartments and timescales. (ii) characterizing additive leaching kinetics to quantify how intentionally added substances (plasticizers, flame retardants, stabilizers) are liberated during weathering and contribute to net microplastics toxicity. The integrated framework will transform microplastics risk assessment from static polymer classification into predictive modeling of coupled chemical transformation and ecotoxicological impact, enabling evidence-based polymer design and environmental policy support.

01.10.2026, 1.25 PM, KeyNote Lecture #169

Session B02.2: Micro- and Nanoplastics: Cell-to-Organism Biological Effects (Bronco & Vozzi)

A04 Holger Kress, Anja Ramsperger & Christian Laforsch

Which properties of microplastic particles are relevant for their interactions with cells?

Microplastic particles are highly diverse in polymer type, size, shape, and surface chemistry. This diversity makes it difficult to compare results across studies and to identify general principles that govern their biological effects. Importantly, even seemingly standardized and nominally identical model microplastic particles can differ substantially in their surface properties, leading to strongly different interactions with cells. To move towards more predictive and comparable microplastics research, it is therefore crucial to identify which particle properties are mainly relevant for interactions with cells.

Here, we address this issue by using single cells as a reductionist model system and focus on particle properties that control the earliest steps of microplastic–cell interactions: adhesion to the cell surface and internalization into cells.[1] Our measurements are based on a microfluidic microscopy platform with machine-learning based image analysis. We show that surface-related parameters vary widely across microplastic models and are further altered by environmental exposure. However, our results also indicate that this complexity can be reduced by concentrating on key properties that dominate particle–cell interactions. In particular, we find that the ζ-potential of particles is strongly linked to the adhesion strength between the particles and cells. Furthermore, we show that the adhesion strength is a good predictor for subsequent internalization into the cells. Overall, our work highlights that a thorough physicochemical characterization of microplastic particles is crucial for assessing their biological impact and for developing a more mechanistic understanding of microplastic effects on living systems.

01.10.2026, 02:40 PM Lecture #254

Session B02.2: Micro- and Nanoplastics: Cell-to-Organism Biological Effects (Bronco & Vozzi)

A03 Jan Bollmann; Schmitt, J.; Ochs, M.; Ritschar, S.; Brehm, J.; Gröschel, L.; Schmalz, H.; Laforsch, C.; Römpp, A.

Multimodal imaging approach for the characterisation of microplastic particles and resulting biological effects in tissue sections

Microplastics are ubiquitous environmental contaminants and have been detected in various biological samples. Their small size and chemical stability pose significant analytical challenges, particularly in complex biological matrices. Imaging-based spectroscopic techniques allow the direct detection and identification of microplastics within tissue sections. In this study, the freshwater mussel Dreissena bugensis was used as a model organism and fed algae supplemented with either aged polystyrene or polypropylene particles containing 1% Irganox, reflecting environmental conditions. We present a multimodal imaging workflow that sequentially combines FTIR imaging, Raman imaging, and MALDI mass spectrometry imaging on the same tissue section. This approach enables spatial localization and identification of microplastics and molecular features in adjacent tissue.

Mussels were collected from the river Regnitz near Bamberg, Germany, shock-frozen in liquid nitrogen, and sectioned at −24 °C. Coronal sections (20 µm) were mounted on gelatin-coated CaF_2 windows and dried. After light microscopic inspection, sections containing potential particles near the stomach epithelium were analyzed by FTIR imaging (Bruker Lumos II) in transmission mode. Polymer identification was performed by Raman imaging (WITEC ALPHA 300 RA+). For MALDI imaging, matrices were applied and measurements were performed at a pixel size of 20 µm (AP-SMALDI5 AF source coupled to a Q Exactive™ HF mass spectrometer). Data were processed using Mirion, MSI Reader, and in-house software.

FTIR imaging enabled rapid screening and precise localization of microplastic particles within cryosections. Raman imaging provided high-resolution vibrational spectra, allowing reliable discrimination between different polymer types. MALDI mass spectrometry imaging revealed specific molecular signatures in tissue areas adjacent to the particles, indicating localized chemical changes. The sequential application of these complementary

techniques on the same tissue section enabled a detailed spatial and chemical characterization of both microplastics and their surrounding biological matrix.

This study demonstrates that a multimodal imaging workflow is an effective approach for detecting and chemically characterizing microplastics in tissue sections. The combination of FTIR, Raman, and MALDI imaging offers a solid basis for future investigations of microplastic–tissue interactions.