Unravelling the knot: Microplastic properties and their correlation with the cellular response

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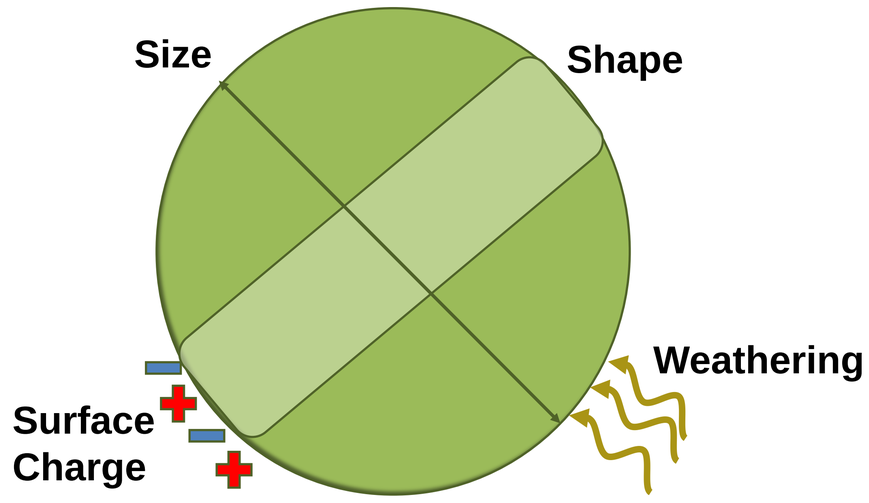
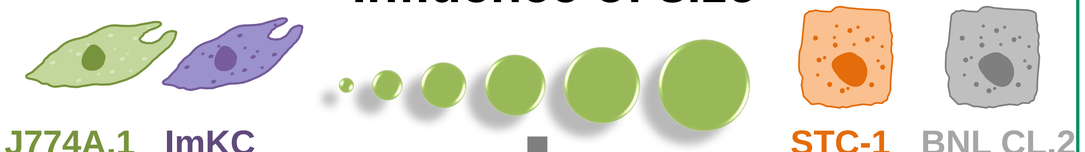
The **influence of different microplastic properties** was investigated with murine macrophages (**J774A.1** / **ImKC**) and epithelial cell lines (**STC-1** / **BNL CL.2**).
Microplastic (polystyrene) was purchased directly from a commercial supplier (i.e., pristine, size / charge) or artificially aged (shape / weathering) and analysed by dynamic light scattering (size), scanning electron microscope (shape) and ζ-potential (charge).
Standard toxicity assays (**MTT** – metabolic activity, **ROS** – reactive oxygen species, **LDH** - membrane integrity, **COMET** – genotoxicity, **TNF-α** – inflammation cytokine) were conducted to analyse the different biological reactions MPs induce to the treated cells.
Size dependent cytotoxicity was found with a higher influence for MPs between 1 – 3 µm but with an overall low cytotoxicity for pristine beads in macrophages. Little to no uptake or effect was found for epithelial cells.
Surface charge influenced the uptake of particles strongly and subsequently increased the cytotoxicity.
Irregular **shape** of the particles had a high impact on the cell membrane integrity and therefore critically influence on the cells fitness.
Artificially weathered MPs showed differences in all relevant particle properties and consequently induced different noxic effects as recorded by various biological assays.

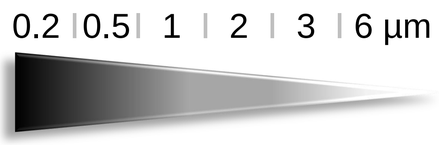
Microplastic properties with potential effects



Influence of size



Uptake/MTT/ROS measurements



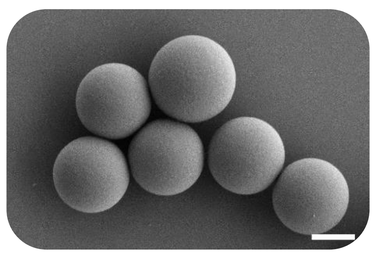
Size dependent **uptake**

Size dependent **cytotoxicity**

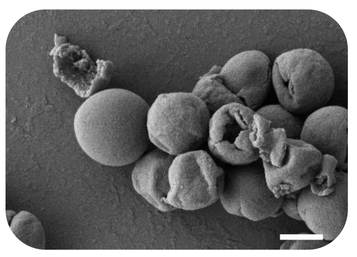
Size-dependent but only **slight** cytotoxicity for **pristine** particles

Charge influences **strongly uptake** and subsequently **cytotoxicity**

Influence of shape

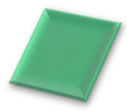


Regular beads



Irregular - sharp edges

LDH Measurement



low LDH release

High LDH release

Highly shape dependent cytotoxicity

Highly weathering dependent biological effects

Influence of surface charge

3µm particles

High charge

Low charge

Uptake/MTT/Proliferation measurements

Charge-dependent **uptake**

Uptake-dependent **cytotoxicity**

Influence of artificial weathering

Metabolic activity
Membrane integrity
Reactive oxygen species
Genotoxicity
Inflammation

Völkl M. et al. (2022): Pristine and artificially-aged polystyrene microplastic particles differ in regard to cellular response. In: Journal of Hazardous Materials 435, S. 128955. DOI: 10.1016/j.jhazmat.2022.128955

Ramsperger, A. F. R. M.; Jasinski, J.; **Völkl**, M. et al. (2022): Supposedly identical microplastic particles substantially differ in their material properties influencing particle-cell interactions and cellular responses. In: Journal of hazardous materials 425, S. 127961. DOI: 10.1016/j.jhazmat.2021.127961.

Rudolph, J.; **Völkl**, M. et al. (2021): Noxic effects of polystyrene microparticles on murine macrophages and epithelial cells. In: Scientific reports 11 (1), S. 15702. DOI: 10.1038/s41598-021-95073-9.

Summary: The physical and chemical properties of microplastic particles are highly relevant for the biological impact and cellular response with an **irregular, highly charged and weathered** surface showing the **highest thread** for cells.

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