The ζ-potential of nominally identical microplastics determines their interactions with cells

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Abstract

As microplastic particles (MPPs) are ubiquitously present in the environment, concerns about possible adverse effects on ecosystems, organisms, and human health were raised. However, the results of previous toxicological studies were often inconsistent, as even nominally identical model MPPs can differ in their physicochemical properties. The determinants and mechanisms governing the relation of these physicochemical particle properties and MPP-cell interactions are not well understood. Therefore, we now quantified the MPP-cell adhesion of non-functionalized polystyrene microbeads from eight different manufacturers. Although nominally identical, these MPPs strongly differed in their ζ-potential, which was additionally altered by the formation of an eco-corona after environmental exposure. Using a microfluidic microscopy platform together with image processing based on artificial intelligence, we found that the absolute value of the ζ-potential was strongly correlated to the MPPs' binding kinetics and adhesion strength. MPPs with a higher absolute ζ-potential bound faster to cells, unbound slower from cells, and remained bound more often under a shearing force compared to MPPs with a lower absolute ζ-potential. Overall, our results show that the ζ-potential of nominally identical model MPPs determines their adhesion to cells, indicating that MPP-cell interactions are strongly influenced by this electrostatic parameter. Since adhesion and internalization of MPPs by cells are important entry routes of MPPs into tissues and organisms, our work contributes to a more mechanistic understanding of the risks caused by the ubiquitous microplastic pollution.

Keywords: microplastics, cells, zetapotential, ecocorona, microfluidics

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