Probing polystyrene nanoparticles interactions with biological macromolecules by an integrated NMR-based approach

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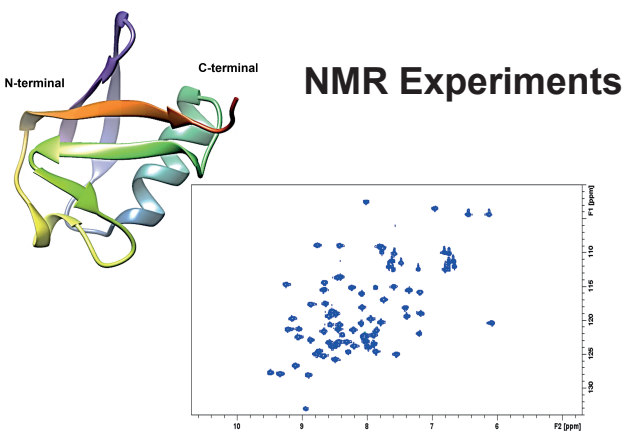
INTRODUCTION

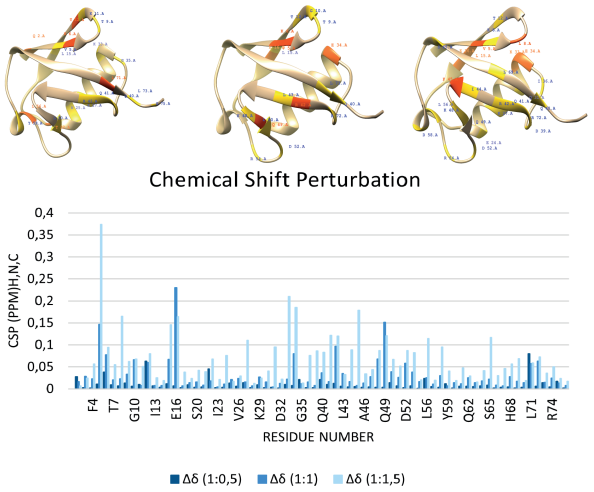
The presence of micro- and nano-plastics in the water, air and food is becoming a significant concern[1]. Most of the works reported in the literature are mainly focused on the micro/nano-plastic accumulation in marine organisms. Moreover, it has been demonstrated that human exposure occurs largely through ingestion, but also in a less well-defined manner through inhalation[2]. Despite, these numerous studies the consequences of micro- and nano-plastics explosion on human health are yet unclear. Therefore, it is extremely important to understand if and how nano-plastics (i.e. polystyrene) interact with biological macromolecules, inducing conformational changes and inhibiting their main functions.

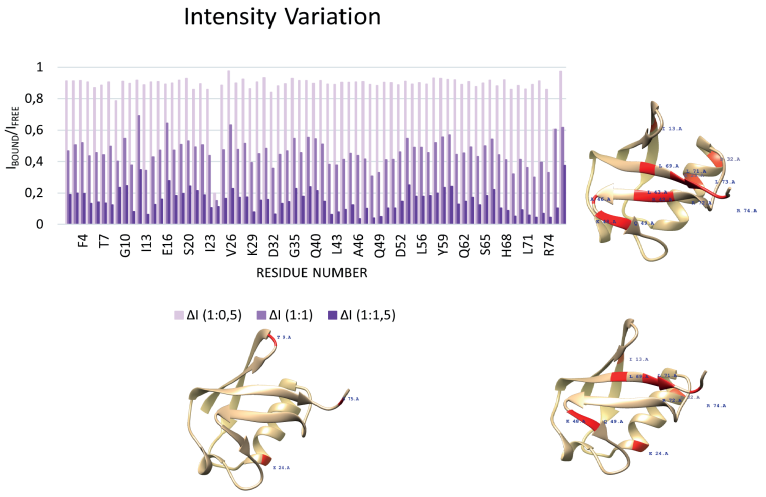
In the frame of this project, we performed a structural and dynamical characterization of the human ubiquitin in the presence of polystyrene nanoparticles by using a multidisciplinary approach in which TEM (Trasmission Electron Microscopy) and CD (Circular Dichroism) data were integrated with high-resolution NMR (Nuclear Magnetic Resonance) methodologies. Overall, our data strongly indicate that upon addition of nano-polystyrene the ubiquitin undergoes local conformational rearrangements, which in turn activate aggregation processes.

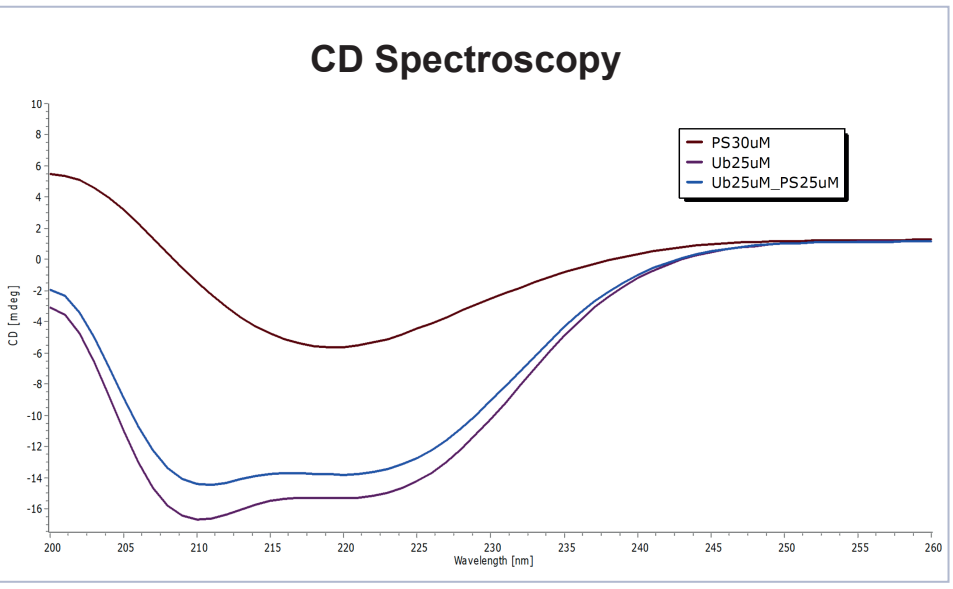
RESULTS

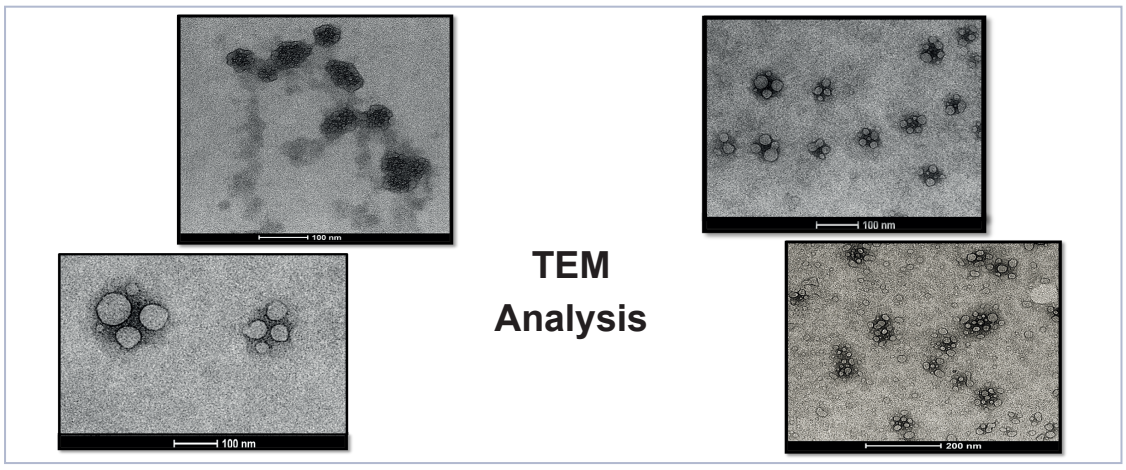


^{1}H-^{15}N HSQC of $^{15}N/^{13}C$-Ubq acquired @ 600MHz, 298 K and pH 7









CONCLUSIONS

The molecular structural details have been investigated by means of multidimensional NMR analysis, combined with TEM data, and have shown that the ubiquitin forms aggregates induced by the interaction with plastic nanoparticles.

Structural and functional studies of ubiquitination in vitro and in cell are in progress to demonstrate biological effects of nanoplastics on cellular metabolism.

References

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[2] C. Q. Ying Yong, S. Valiyaveetill, B. L. Tang Int. J. Environ. Res. Public Health Rev. 17, 1509 (2020)