STSM: Multiple-particle tracking for microstructure characterization

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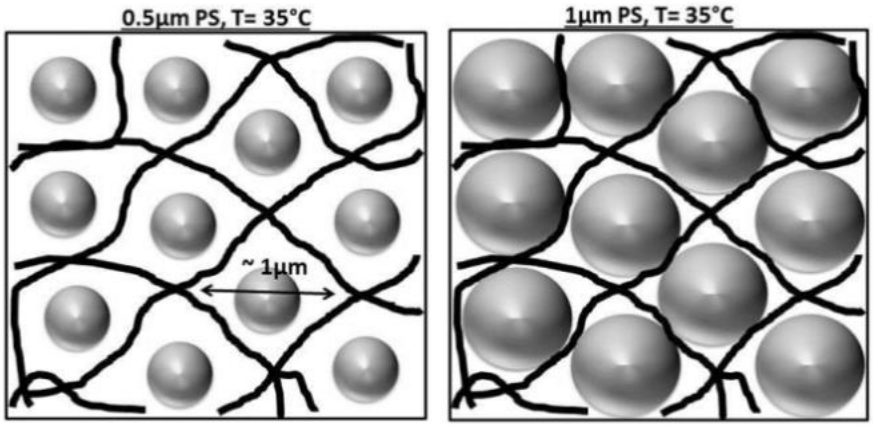
Starch is a renewable biopolymer with a low cost that finds broad use nowadays, but there are still new opportunities to be explored. Temperature-sensitive starches have found an application in the packaging industry. With the existing technologies to produce these starch grades, highly toxic quaternary amine reagents are used. In this work, environmentally friendly non-toxic thermosensitive starch-based materials were used.

The main objective of this STSM visit was to investigate the microstructure and microheterogeneity in these thermosensitive starch-based solutions and suspensions by the help of multiple-particle tracking (MPT) and to gain unique understanding for the relationship between structural, micro and macro-rheological properties.

A binary starch-pluronic F127 system and a ternary silica-pluronic F127-strach system were characterized by the help of classical bulk mechanical rheometry and multiple-particle tracking. Most interesting findings revealed the results from the ternary mixtures.

The microstructure of thermosensitive ternary Silica-PF127-Starch mixture in the gel state (T=35°C) has a complex form, which consists presumably of an elastic matrix composed of silica particles with adsorbed pluronics and of viscous areas with characteristic length scale less than 1 µm within the elastic matrix. By varying the starch concentration, the characteristic length scale of the viscous regions and the homogeneity of the material can be controlled. These viscous regions can be used as pores for controlled release of active components at temperature change.

By studying temperature responsive starch-based systems, new more environmentally friendly and non-toxic materials, could find their future application way in order to improve the functionality of active and intelligent fibre-based packaging in terms of controlled release of active components at temperature change, temperature indicators and time-temperature indicators, temperature controlled barriers for respiratory food products, 3D-printing for anti-counterfeiting, etc.



Schematic representation of the gel microstructure according to the MTP results for 0.5µm fluorescent tracers (left) and 1µm fluorescent tracers (right) tracers. Black lines represent the elastic network composed of silica particles with adsorbed pluronics, surrounded by viscous solution containing polymers.