Contribution ID: **185** Type: **Talk**

Formation of multistranded β-lactoglobulin amyloid fibrils and their stimuli responsive magnetic behaviour in the lyotropic liquid crystals

Friday, 16 September 2011 10:20 (25 minutes)

We investigated snapshots of the fibrillation and aggregation kinetics of multi-stranded β-lactoglobulin amyloid protein fibrils at pH 2 and 90 ℃ by combining scattering (SANS, DLS, DDLS) as well as atomic force microscopy (AFM) 1. Scattering techniques clearly demonstrate the structural conversion and time evolution of β-lactoglobulin monomers (2 wt %) into semi-flexible protein fibrils upon heating at 90℃. AFM allowed resolving the critical steps for the formation of single protofilaments, their alignment driven by liquid crystalline interactions and the twisting of the final fibrils due to the intra-molecular electrostatic interactions, leading to the development of multistranded twisted ribbon fibrils 2. In further, β-lactoglobulin fibrils were titrated with a sulfated polysaccharide (k-carrageenan) to determine the morphology and mechanism of complex formation. SANS and microscopy indicated the complex formation of spherical aggregates attached along their contour length of the multistranded twisted protein fibrils, arranged in a necklace configuration 3.
In addition, we investigated the encapsulation of the β-lactoglobulin fibrils, fibrils coated with magnetic nanoparticles into the three different types of lyotropic liquid crystalline (LLC) meso phases. Mesophases composed of glycerol monolinoleate, linoleic acid and water yielding respectively lamellar, inverse bicontinuous cubic and inverse columnar hexagonal symmetries 4. The impact of fibrils confinement within the LLC on their secondary structure, spatial organization and their response to an external magnetic field stimulus5 was studied by combining small angle X-ray and neutron scattering (SAXS, SANS), ATR-FTIR and AFM techniques.

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Session Classification: Soft Condensed Matter

Track Classification: Soft Condensed Matter