Creating 3D-Networks and Hydrogels from Self-Assembling Peptides

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Molecular self-assembly is a powerful tool for the preparation of molecular materials with a wide variety of properties. This is illustrated by the abundance of self-assembled proteins and polysaccharides encountered in Nature. Peptides are particularly promising as building blocks for a number of reasons. The natural amino acid pool consists of 20 members with different physical properties including polar, non-polar, acid, basic and aromatic groups. In addition, an infinite number of unnatural amino acids can be designed in the laboratory. Amino acids can be combined in endless different ways leading to a vast number of building blocks with different physical properties. However, the understanding of the molecular interactions and self-assembly rules in these materials is still limited, consequently, the fundamental link between building block structure, mesoscopic structure and material properties has not yet been elucidated.

In our work we decided to undertake a systematic investigation of the self-assembly and gelation properties of a series of octa-peptides. Small angle neutron scattering (SANS) was used to investigate the structures formed. In addition to SANS, atomic force microscopy (AFM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR) and micro differential scanning calorimetry (μ-DSC) were used to characterise our systems.

In our presentation we will show how the amino acid nature and sequence affect the self-assembly and gelation ability of these peptides. By manipulating the peptides chemical architecture we were able to obtain non self-assembling peptides, self-assembling peptides that do not form hydrogels and self-assembling peptides that form hydrogels with different type of network topologies and therefore mechanical properties. The number of structures and morphologies obtained show how versatile peptide self-assembly can be and how a fundamental understanding of the self-assembly and gelation rules could lead to the creation of new materials with properties tailored to specific applications.