Collagen Fibres and Self-Assembled Peptides

Self-assembled collagen fibres and peptide structures are gaining prominence in both biomedical and materials science applications. Collagen networks form a fundamental part of the extracellular matrix and are crucial to the mechanical and functional integrity of connective tissues. Their spatial arrangement is closely linked to pathological processes such as fibrosis, tumour progression, and wound healing. Self-assembling peptides—such as Fmoc-FF and other aromatic di- and tri-peptides—are increasingly studied for their ability to form nanostructured networks, including rods and fibrils, which can mimic extracellular environments and serve as scaffolds in hydrogels, bioinks, and 3D tissue models.

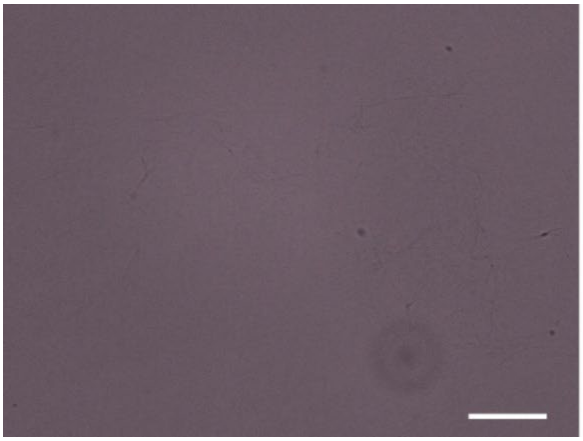
Imaging these materials is key to understanding their formation, architecture, and suitability for biomedical use. Assessing fibre morphology, alignment, and density informs material design for applications like cell culture, tissue engineering, and drug delivery. These assemblies are also relevant to neurodegenerative disease research, as larger peptide aggregates can adopt amyloid-like structures. As interest grows in functional biomaterials based on supramolecular assembly, there is increasing demand for imaging techniques that can capture their morphology accurately and efficiently.

Electron microscopy techniques such as SEM and TEM are widely used for visualising nanoscale assemblies, but they require extensive sample preparation, operate under vacuum conditions, and are less suited to rapid screening. When similar structural information can be obtained using optical methods such as HaloMicroscopy, the benefits in terms of speed, accessibility, and workflow integration are significant. HaloMicroscopy enables high-contrast, preparation-free imaging of delicate peptide and protein-based structures, making it particularly useful for research and quality control in materials and biomedical development.

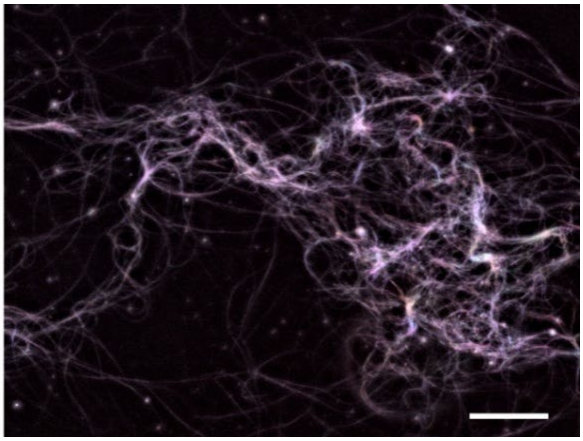
Structural Contrast in Brightfield and HaloMicroscopy

Collagen fibres and self-assembled peptide structures were imaged in liquids using brightfield and HaloMicroscopy under matched optical conditions to enable a direct comparison of contrast, structural clarity, and visual information content. The results demonstrate clear differences between the two modalities, with HaloMicroscopy providing markedly improved definition and more effective visualisation of fine features such as thin fibres, rod-like assemblies, and overlapping networks.

Comparison of collagen fibre morphology imaged using brightfield and HaloMicroscopy:

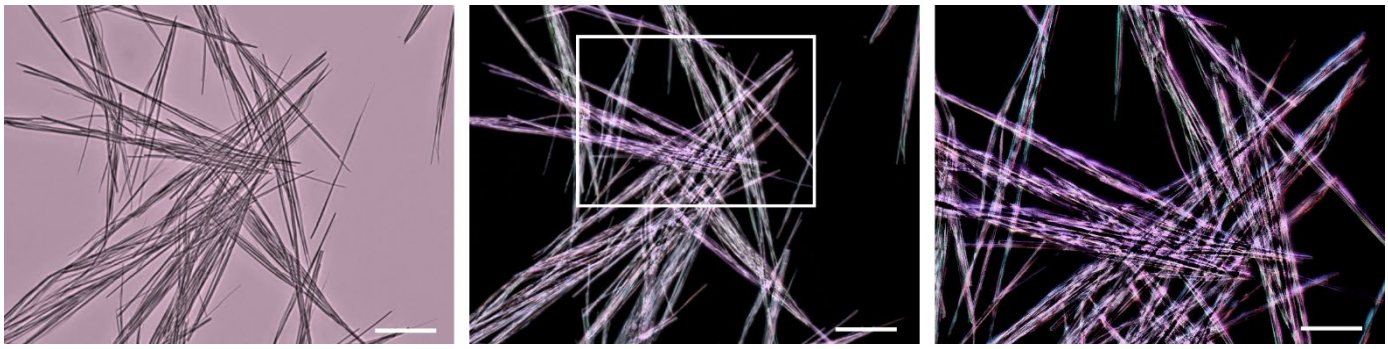


Brightfield image: Thin fibrous structures are faint and lack contrast; with poor separation between overlapping regions and limited visibility of fine detail. (Scale bar = 40 µm)



HaloImage: Structural clarity is greatly enhanced, revealing distinct individual fibres, spatial organisation, and variations in density and alignment. (Scale bar = 40 µm)

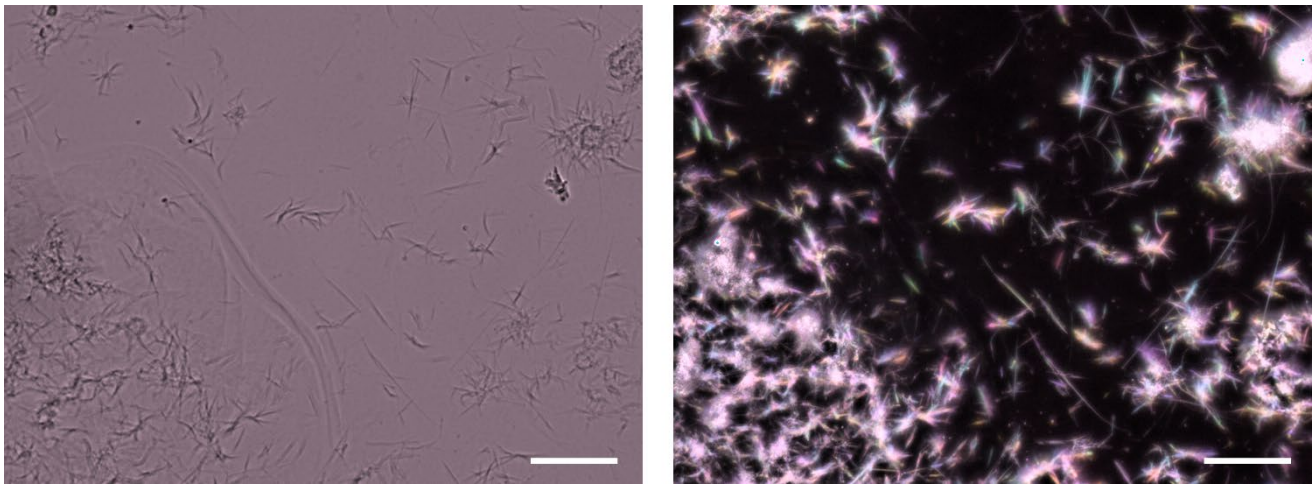
Brightfield, and HaloImages of self-assembled hyp–phe(F5)–phe(5F) peptide structures:



Brightfield image: Rod-like peptide assemblies are visible as dense, aligned fibres, though internal texture and overlapping details remain indistinct. (Scale bar = 40 µm)

HaloImage reveals enhanced contrast and separation of intersecting fibres, highlighting variations in orientation and density.
The higher-magnification view (scale bar = 20 µm) further resolves internal features within the bundles, revealing sub-structural variation and potential heterogeneity in packing.

Brightfield and HaloImage comparison of the self-assembled peptide sample:



Brightfield image: Needle-like and clustered structures are visible but poorly resolved, with minimal contrast and limited structural interpretation. (Scale bar= 40 µm)

HaloImage: Enhances the visibility of distinct aggregates and subtle assemblies, revealing structural heterogeneity and internal organisation within peptide clusters. (Scale bar= 40 µm)

The HaloImaging results reveal a striking improvement in structural clarity, capturing the morphology of self-assembled peptide networks with unprecedented definition. HaloMicroscopy allows detailed visualisation of rod-like and fibrous assemblies formed by peptide-based materials such as Fmoc-FF and its analogues, which are of growing interest in hydrogel development, bioink formulation, and cell culture systems. This capability not only supports material optimisation for biomedical applications but also opens the door to directly studying amyloid-like architectures and other complex self-assembled nanostructures.

