Analysis of Emergent Electronic Properties of Self-Assembling Nucleopeptides

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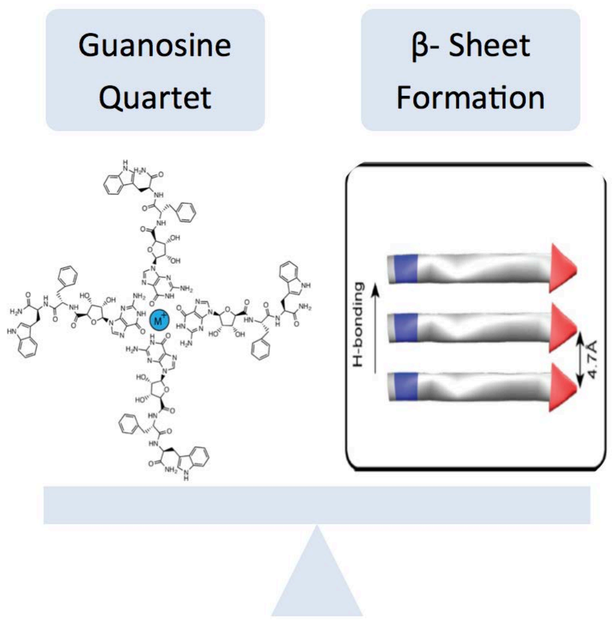
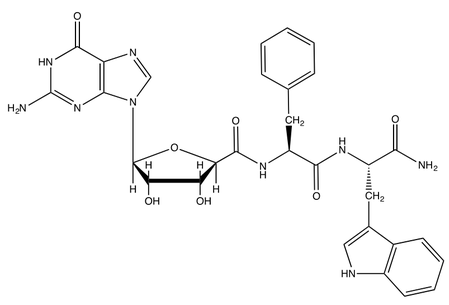
Abstract

Biomolecular structures are held together by a complex network of molecular interactions that direct assembly and stabilize structures. In order to translate the fundamental molecular interactions of biomolecules into the design of functional biomaterials, we have developed a model system that integrates nucleic acids and self- assembling peptides. These nucleopeptides serve as a small-model system for the study of the non-covalent molecular interactions involved in biomolecule self-assembly. We have scaled up and expanded the analysis of our original nucleopeptide library in order to further characterize these assembled structures. Infrared (IR) spectroscopy, Atomic Force Microscopy (AFM), and Transmission Electron Microscopy (TEM) were utilized to characterize the assembly structure and image the supramolecular morphology of the nucleopeptides. The emergent electronic properties of the nucleopeptide assemblies were analyzed by Electrical Impedance Spectroscopy (EIS). Collectively, these studies on nucleopeptide supramolecular structure assembly will contribute to the design of functional biomaterials with the potential to conduct and store electrical charge.

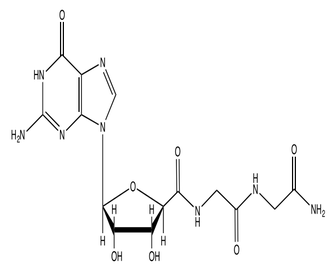
Supramolecular Secondary Structures



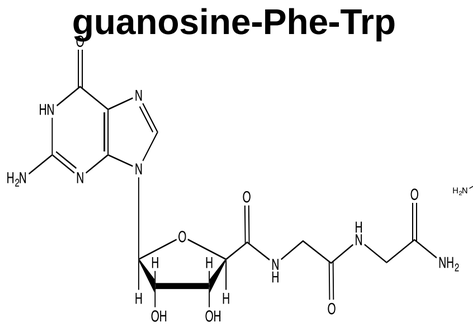
Nucleopeptide Library



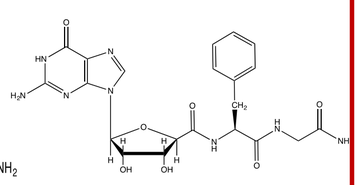
guanosine-Phe-Trp



guanosine-Gly-Gly

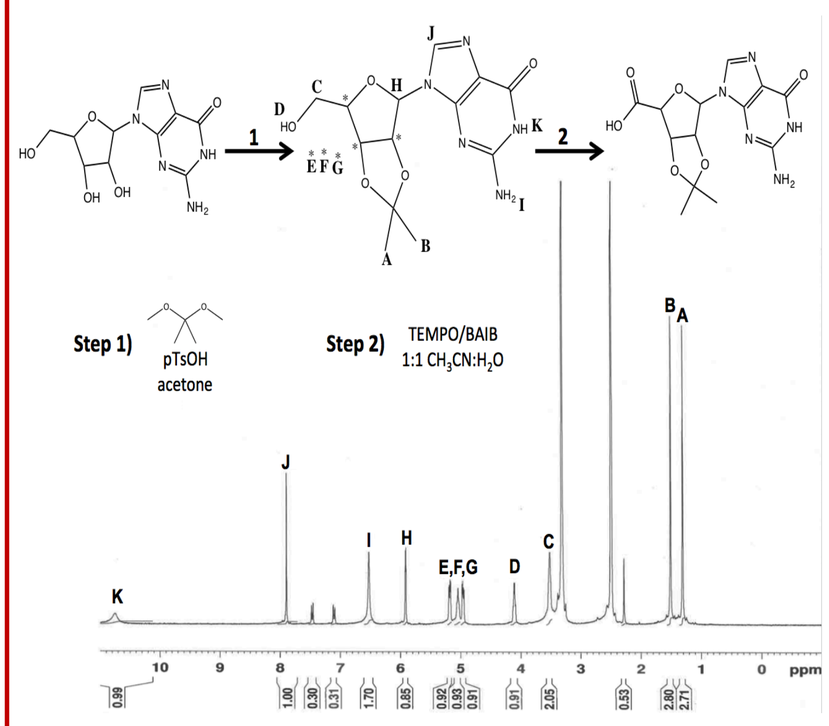


guanosine-Phe-Phe



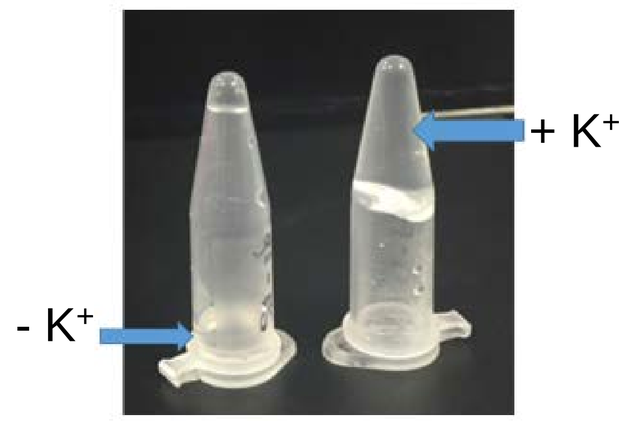
guanosine-Phe-Gly

Methods



Nucleopeptide Hydrogels

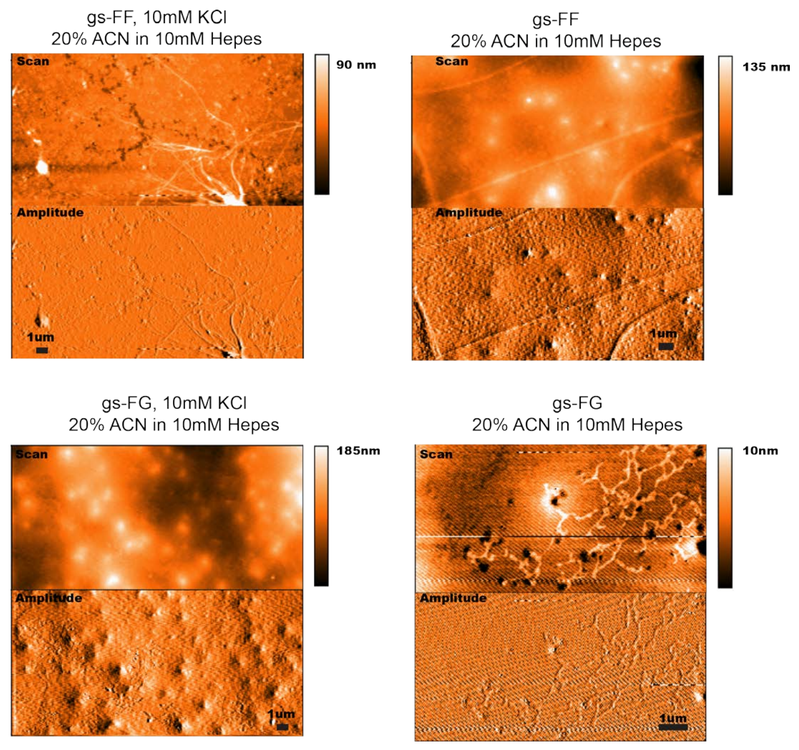
gs-FG



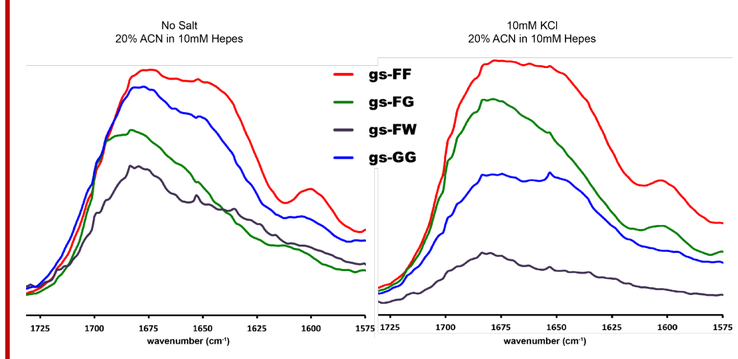
Hydrogel Formation
(time to form)

	gs-FF	gs-FG	gs-FW	gs-GG
No Salt	No	No	Yes (2wk)	Yes (2wk)
10mM KCl	No	Yes (1d)	Yes (1d)	Yes (2wk)

Atomic Force Microscopy

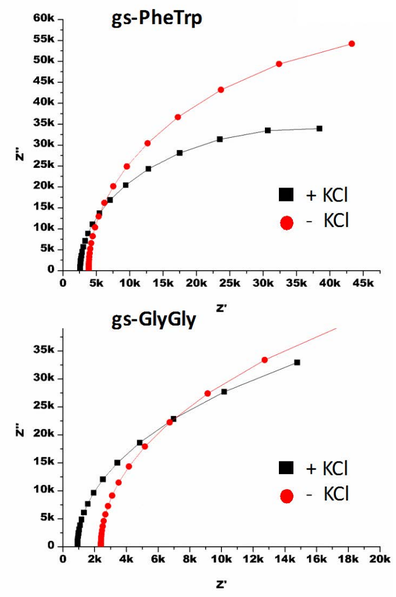


Infrared Spectroscopy



Electrical Impedance Spectroscopy

- Nyquist Plots measure the impedance of the system in terms of resistance and capacitance of a system.
- There is a constant increase in impedance with a better conductivity given by the gels containing KCl.
- gs-GlyGly and gs-PheTrp gels containing KCl have *better conductivity with a higher capacitance*
- Potential for hydrogels to store electrical charge and behave as a sensor.



Preliminary Successes and Future Experiments

- Successful synthesis and purification of guanosine modified nucleopeptides (gs-FF, gs-FG, gs-FW, gs-GG)
- Characterization of nucleopeptide supramolecular structures by AFM, Infrared Spectroscopy and Electrical Impedance Spectroscopy

Expand assembly conditions (solvent, salts and concentrations)

- Characterize hydrogel mechanical properties
- Expand the nucleopeptide library

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