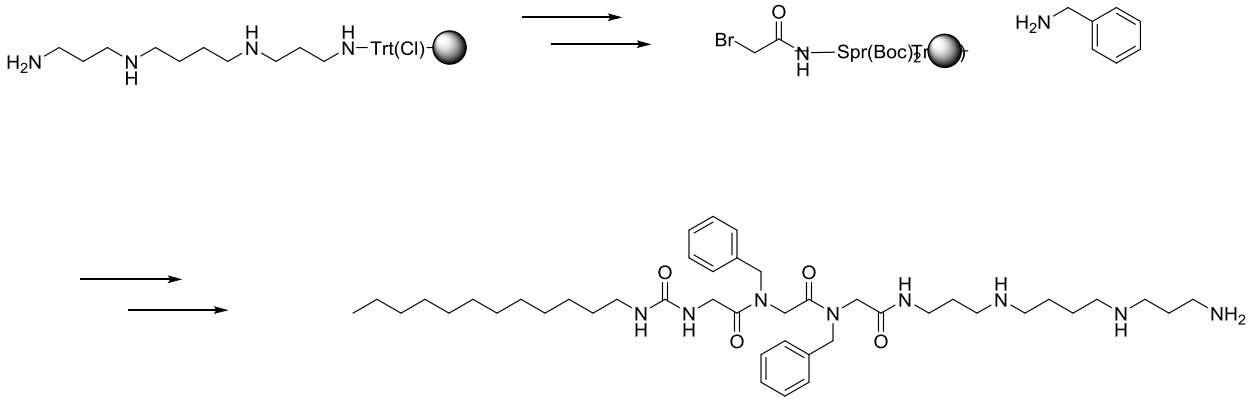
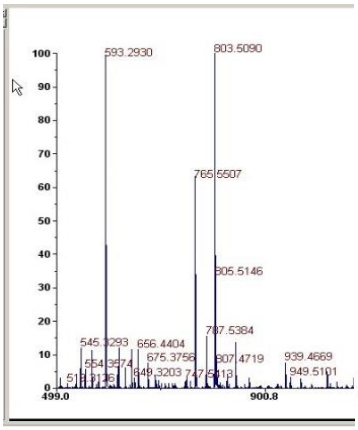
The Evolution of Self-Assembled Organic Materials---PRF Per. Rep. Yr. 1---Grant #57434
PI Martin Conda-Sheridan (University of Nebraska Medical Center)--- martin.condasheridan@unmc.edu
Co-PI Sangjin Ryu (University of Nebraska Lincoln)

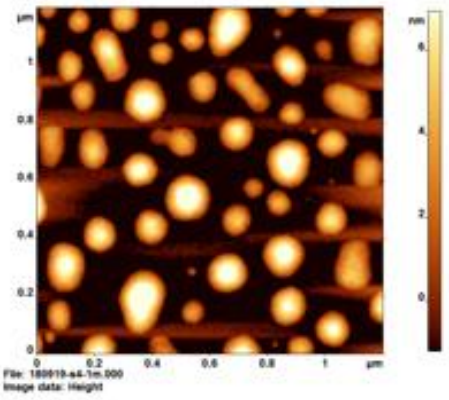
The goal of our project is to prepare new organic-based self-assembling systems using the Peptide Amphiphiles as a template. Basically, we will use the principles that guide the self-assembly of those molecules to evolve these materials to create more robust systems that may have applications in catalysis or as templates for other supramolecular structures. Several positive outcomes were obtained. Firstly and most important the funds were used to foster the career of a graduate student and a postdoctoral fellow. A new student has since joined the project. They all received training on the synthesis and purification of self-assembling materials made by solid phase organic synthesis. They were able to learn transmission electron microscopy, atomic force microscopy, and circular dichroism. They were able to perform the characterization of the nanostructures using the mentioned techniques. Being able to perform those techniques will help then in their future careers. For me, it has been a fantastic opportunity, it has allowed me to interact with my collaborator and a new investigator (Dr. Jae Sung, also from Univ. of Nebraska Lincoln). We submitted a grant to NSF, even though it did not get funded, it helped us to refine objectives and plan future directions. More important, this grant is providing the needed funds to explore a new set of materials.

Following our previously published paper[1], we were able to create new amphiphilic materials based in peptoids and polyamines. All the studied compounds were prepared using a chlrotrityl resin support by solid phase organic synthesis. The structure of one of these molecules with a simplified synthetic scheme is shown below.



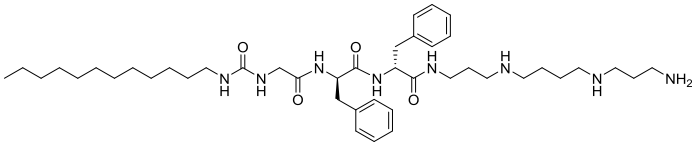
The target compounds were purified by liquid chromatography and characterized by MALDI mass spectrometry. The powders were then dissolved in water, their pH adjusted at 7, and the systems annealed at 80°C for 3 hr. We found many of the molecules (but surprisingly not all) assembled in distinct morphologies as can be seen in the atomic force microscopy picture. The molecule above was shown to form micelles as seen by atomic force microscopy (we were not able to detect supramolecular structures by TEM). We presume this morphology is a consequence of the peptoid residues, which lack H-bonding capabilities (the presence of groups with H-bonding potential should favor the formation of nanofibers). We are planning to submit the samples to a collaborator to perform SAXS on then to get a better idea of their. In addition, we started working on a molecular theory that can predict the morphology of a self-assembled system from its individual components.[2] We are using the systems synthesized on this grant to refine and validate our model.

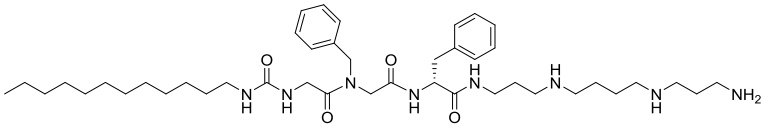




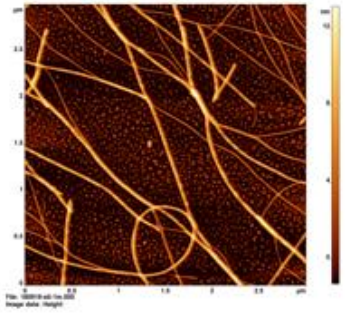
All together we have prepared ten structures with diverse compositions (we needed to optimize coupling conditions and find the best precursors) to understand how modifications near the alkyl tails alter supramolecular structure. Thus, while the target molecules are polyamines with peptide and urea bonds, some of the controls included nanosystems containing amino acids or amide linkages. An interesting finding is that while the presence of urea triggers self-assembly, molecules containing the amide bond, usually, do not form supramolecular nanostructures. This indicates the role that strong H-bonding groups near the core have on the process.

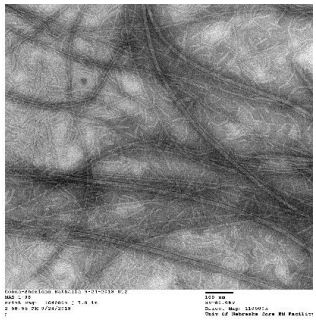
The Evolution of Self-Assembled Organic Materials---PRF Per. Rep. Yr. 1---Grant #57434
PI Martin Conda-Sheridan (University of Nebraska Medical Center)--- martin.condasheridan@unmc.edu
Co-PI Sangjin Ryu (University of Nebraska Lincoln)

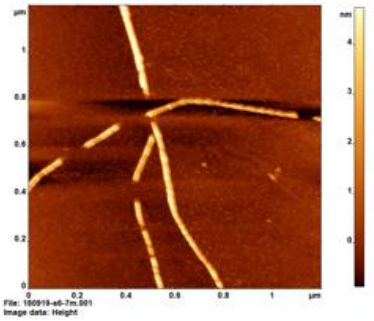


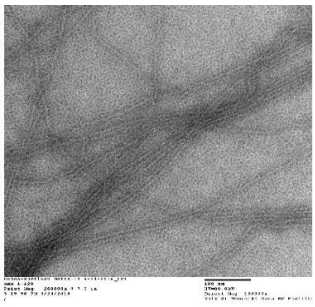


As can be appreciated by transmission electron microscopy and atomic force microscopy, the molecules above form nanofibers of ~20 nm width and micron length.









The next steps of the project will consist in calculating the CMC of the systems and their zeta potential and assessing the role that pH has on the assembly process and differential scanning calorimetry and UV-melting temperatures to assess the stability of the constructs towards heat. We will assess the mechanical properties of the fibers using AFM. Also, we will survey the effect that ionic strength has on the assembly. Our molecular theory indicates that ionic strengths should alter the morphology of the systems from micelles to lamella, thus it will be essential to perform these experimetns to validate our predictions. Finally, we will also create gels and study their properties by rheology and AFM nano-indentation (with Dr. Sangjin Ryu).

1. Samad, M. B.; Chhonker, Y. S.; Contreras, J. I.; McCarthy, A.; McClanahan, M. M.; Murry, D. J.; Conda-Sheridan, M. Developing Polyamine-Based Peptide Amphiphiles with Tunable Morphology and Physicochemical Properties. *Macromolecular Bioscience* **2017**.
2. Zaldivar, G.; Samad, M. B.; Conda-Sheridan, M.; Tagliazucchi, M. Self-assembly of model short triblock amphiphiles in dilute solution. *Soft Matter* **2018,** 14, 3171-3181.