The Hanks group is interested in the fundamental processes of self-assembly and in the construction of functional materials from highly conjugated polymers. We are currently focused on three major areas:

1) **Halogen bonding for the assembly of supramolecular systems.** Halogen bonds, like hydrogen bonds, are highly directional and strong non-covalent interactions that play a role in the crystalline structure of many solids as well as the solution structure of certain proteins and enzyme-substrate complexes. We use quantum mechanical calculations, organic synthesis and supramolecular assembly to build novel structures that help us understand the origin of this poorly recognized interaction.

2) **Polydiacetylene Liposome for pathogen detection and drug delivery.** Liposomes are nanometer scale spheres consisting of a thin bilayer membrane and an aqueous interior. The membrane of our liposomes can be polymerized, which not only greatly stabilizes the structure, but turns the liposomes bright blue. When they are placed under stress, they change to a bright red color. By chemically derivatizing the outside of the structure, we can specify the environmental changes that cause the color change. Of most interest to us right now is the detection of bacteria. We are working with our collaborators at Clemson University and Ben Gurion University in Israel to devise products that quickly and easily identify the presences of pathogens such as *Salmonella* and *E. coli* in food products and food production facilities.

   Another feature of liposomes is that molecules can be trapped in the aqueous interior. Our polymerization makes the vesicle much less “leaky” than conventional liposomes, keeping anything lock up in the interior safe from the environment (and vice versa!). We are currently investigating the use of our liposomes as “containers” that deliver a drug to a particular biological site, and then release it in a burst. We are also interested in using them for imaging within biological systems.

3) **Conducting polymer composites for tissue engineering and biofouling resistance.** We have designed materials that consist of an electrically conducting polymer and a biodegradable polymer. We are building three-dimensional, macroscopic structures that can be seeded with human cells for future use in regenerative medicine. Our constructs are specifically designed to regenerate nerve tissue and may be used in areas ranging from spinal column repair to the treatment of epilepsy to providing interfaces between the nervous system and electronic devices, such as artificial eyes, ears and prosthetic limbs.

   By using a surface modification technique that we have developed, we are also using related conducting polymer composites for coatings on ocean-going vessels. We have shown that our materials resist the growth of diatoms and barnacles. This directly addresses a problem that costs the world economy billions of dollars each year in wasted fuel and cleaning efforts.