Tiffany Williams

Biography

Hiya! My name is Tiffany and I'm entering my fifth year as a Ph.D student in Materials Science and Engineering here at Cornell University. I grew up in Southeastern Virginia and earned my B.S. in Chemistry from the College of William and Mary in 2009. That fall, I started graduate school but within a year I found that I needed a break (as I had been busy with classes, work, and extracurricular activities nonstop since I started college) so I took a leave of absence and worked as an analytical chemist in an environmental testing lab here in Tompkins County. I performed over 15 different assays to assess water quality of samples from households, businesses, and from local streams/lakes. Although the job was quite interesting, after a while I found myself again wanting to perform independent research so about a year later I returned to Cornell to begin working on my current research project.

In my spare time, I enjoy gardening, hiking, and working on various art projects. I've recently taken up painting, but I find my heart lies with collage and photography. I have two cats, Cosmo (a mischievous brown tabby) and Betsy (a mustachioed calico) who like to watch videos of other cats on the internet. I also enjoy long walks on the beach, but am not much of a fan of piña coladas or getting caught in the rain.

Research

My work is concerned with developing high surface-area carbons with hierarchical porosity using colloidal polymer suspensions. Hierarchical porous carbons (HPCs) are of great interest in applications for energy conversion and storage due to their high surface areas, pore volumes, and ease with which species in liquid or gaseous media can move through the structure. I am particularly interested in the application of these HPCs to the production of supercapacitors, which are energy storage devices that can provide both high energy density and high power density. Simply put, an ideal supercapacitor could store a lot of charge like a battery (by having lots of surface area, since capacitance is related to the area of the electrode on which the charge is stored) but discharge and recharge quickly due to the high conductivity of the carbon structure.

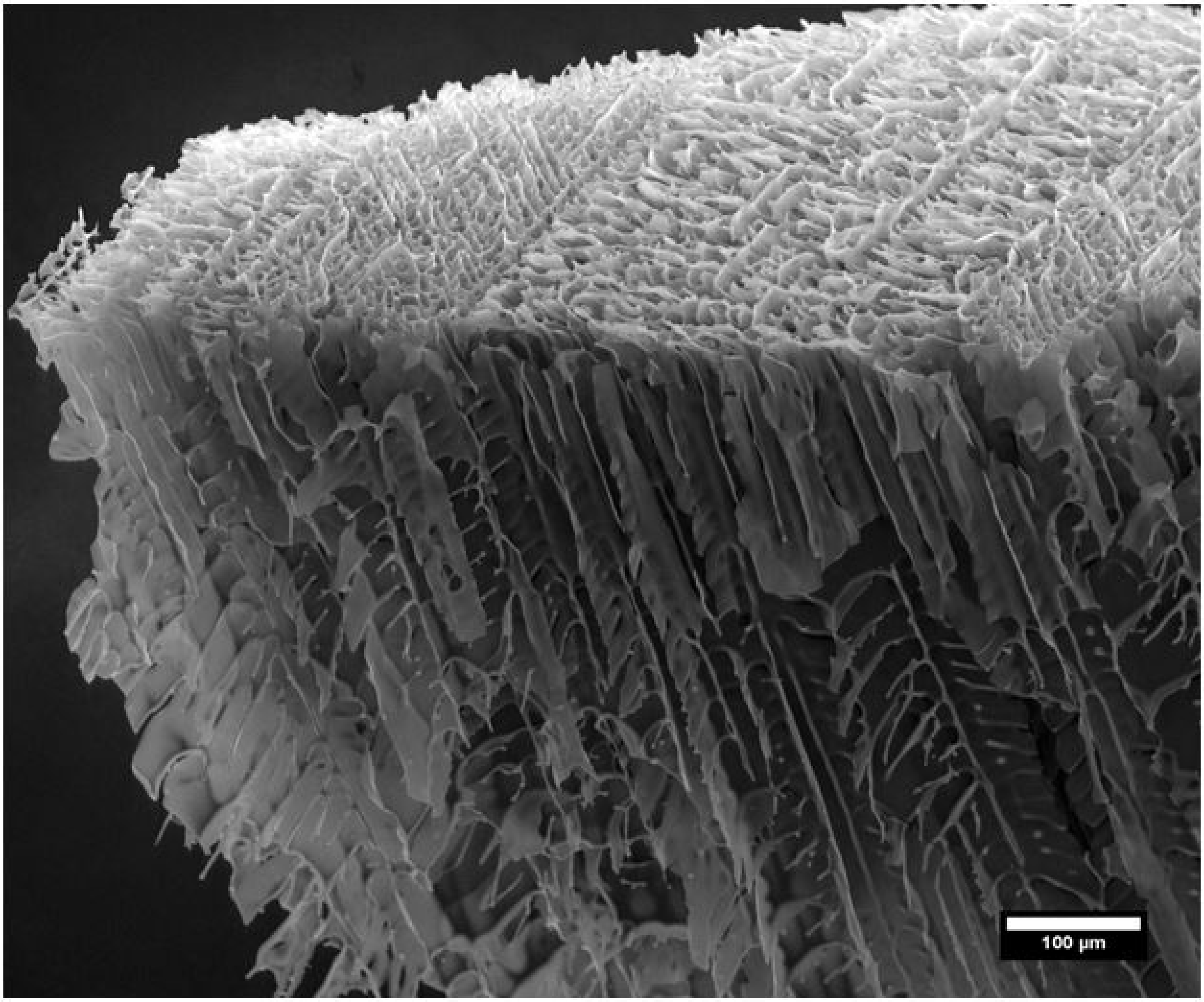

Figure 1: Monolithic structure produced after freeze-casting

To produce these HPCs, I use a method called "freeze casting" to create a large, monolithic structure (akin to a foam) made of my carbon precursor. To do this, a suspension of polymer colloids (typically <10 nm in diameter) is blended with colloidal silica nanoparticles with diameters between 4 and 20 nm. The mixture is then poured into a mold and frozen at a known temperature. As the mixture freezes, there is a phase separation of the ice and colloid phases, where the colloid is pushed into the space between adjacent ice crystals. The solidified ice is removed from the structure through freeze-drying, which preserves the interconnected polymer structure. The pores resulting from the ice crystals are called macropores and tend to be between 1 and 100 um in diameter (the size is dependent on the freezing temperature used). Smaller pores between 2 and 50 nm in diameter, called mesopores, are formed through the etching of the silica template, and even smaller pores (less than 2 nm in diameter) are formed through "activation" of the carbon. The size of these three porous domains may be tweaked independently via changes in synthesis conditions; as a result, carbons having a large variety of pore sizes may be created.

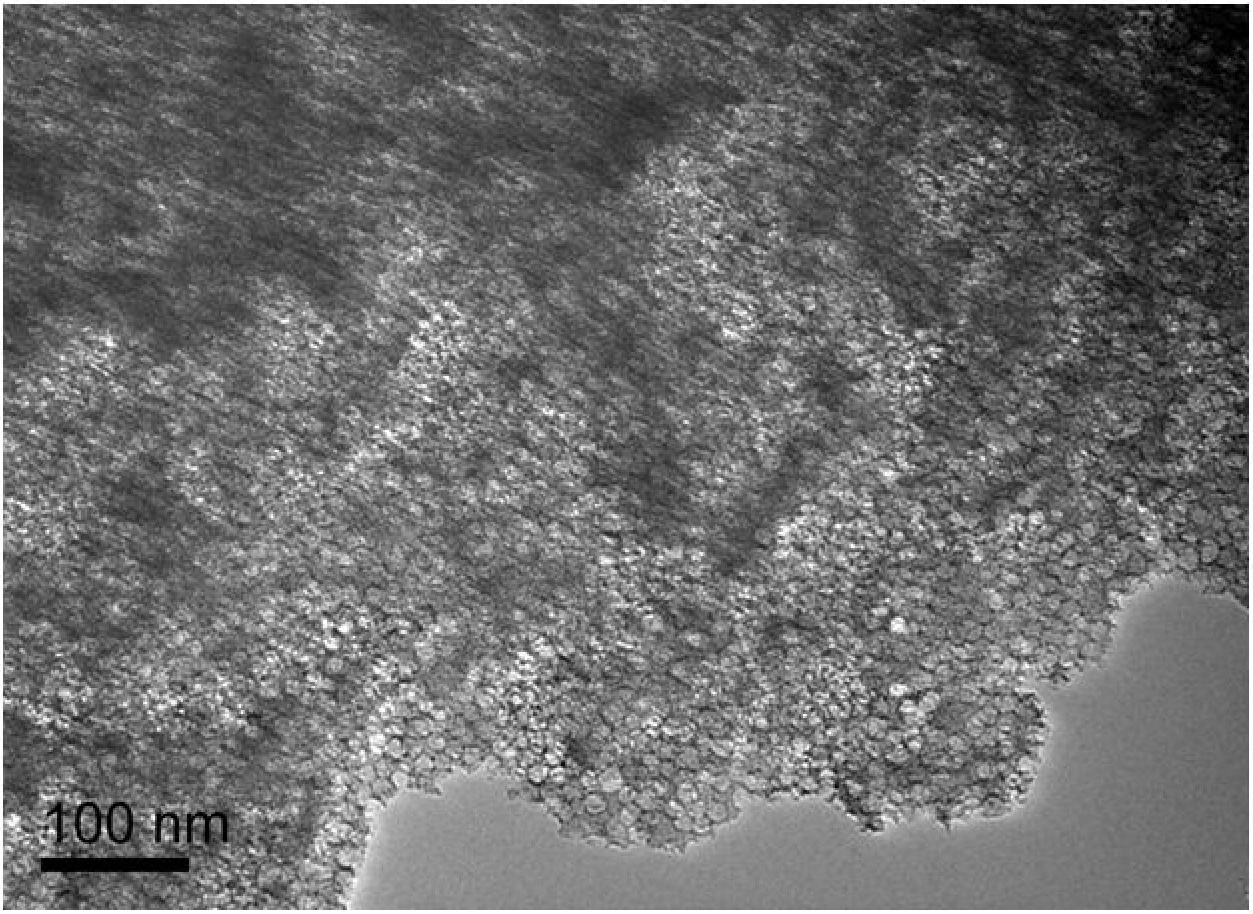

Figure 2: Mesoporous structure produced by silica particle template