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Carbon Nanotubes (CNTs) are nano-scale tubes composed of fused benzene rings. The electronic and optical properties of CNTs are determined by chirality and diameter. CNTs are of great interest in developing a multitude of revolutionary technologies due to these properties.

There is a great hindrance to the development of CNT technologies: There is no current way to make a homogenous batch of CNTs—all the same chirality and diameter. This is a huge roadblock in developing CNT technologies due to the differing characteristics between CNTs of unique chirality and diameter. Cyclophosphazenes (CPPs) are the building blocks of CNTs which should pave the way to the total synthesis of carbon nanotubes.

A general synthesis was developed which is used to create CPPs with diameters of 7-12 benzenes [7-12] Cycloparaphenylene. It hinges upon the syn conformation of a masked benzene ring which has two rings off para positions with aryl substituents.

These syn three ringed pieces are coupled together via an orthogonal Suzuki-Miyaura cross-coupling. These yield a six or nine ringed terminal dichloride depending on the pieces used. Chlorine does not typically participate in Suzuki coupling.

These six and nine ringed terminal dichlorides may undergo coupling into three unique macrocycles each. This is achieved via reactivity granted to the terminal chlorides by Buchwald’s S-Phos ligand to couple with boronic acid esters such as Bpin. These macrocycles are aromatized with sodium napthalenide to form the CPPs.

This synthesis may be reapplied with thiophene to create more electron-rich nanohoops and potentially electron-rich nanotubes which may serve an important role in new solar cell technologies. We have begun pursuing the installation of a single thiophene into a CPP structure to explore this. The single thiophene is to be on a ketone used to build one of the three ring building blocks.

This thiophene-laden 6 ring terminal dichloride is to undergo a Suzuki coupling with the dibpin three ring building block to form a 9 ring nanohoop with a single thiophene.

As this synthesis would hopefully draw heavily upon skills and methods previously developed in the lab it may be easy to execute. An approach which slowly adds more and more thiophenes to nanohoops will be utilized to minimize the number of possible problems with the synthesis encountered along the way.

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