PREFACE: SUPRAMOLECULAR ASSEMBLIES

"I just want to say one word to you, just one word… are you listening? Plastics. There's a great future in plastics. You think about it." From the motion picture "The Graduate" (1967).

In today's dot.com market of get-rich-quick investment options, it is easy to overlook blue chips and other old economy funds. Why settle for investment in a slow growth atom-based company when an information age firm promises revolutionary advances in the way the world thinks and a high price to earnings ratio to match? Seemingly unconnected in investor profit and business strategies, the line between the Old and New economy is usually clear cut and well defined: one supplies a concrete service or product, the other ideas and information. But what does any of this have to do with chemistry, and in particular material science?

First, the advent of the information age would not have been possible without advances in material science. Simply put, new materials must constantly be developed to meet the demands of consumers who insist on more information being fit into smaller spaces. Secondly, and more to the point, the realm of material science merges old world economies with the information based era and blurs the conventional line drawn between the two. Whereas most atom based companies such as shampoo suppliers or clothiers exist solely to ensure the accepted comforts of humans around the world, material science provides a means to not only comfort in the form of atom based products, but also serves to advance the desires of the population as a whole. Imagine a police force void of light-weight bullet proof vests; a roving business force negligent of portable data processing units such as laptop computers; an astronaut remiss of both high-strength, flexible spacesuits and the protective tiling of her spaceship; 21st century parents deprived of the ease and comfort of leak-proof disposable diapers. To be certain, none of the aforementioned materials are necessities. Yet these and other similar advances have become such the norm that they are taken for granted as such. And therein lies the beauty of material science: a novel arrangement of atomic units on the microscopic scale can lead to macroscopic and even worldly benefits, all the while changing the way people think and function in the process.

Thus, what may at first seem like purely speculative advice on a sector fund given by Mr. McGuire to Ben Braddock in the 1967 film "The Graduate" was actually sound counsel given the time period. Not only did Mr. McGuire have history on his side: the production of synthetic plastics and resins had grown from 15,000 tons to over 400,000 tons between the years of 1930 and 1945, reaching three million tons by 1960, he also recognized the widespread appeal of sizable and moldable synthetic thermoplastics. Although it is often difficult to finger one development as being more significant than the predecessors that bore the innovative fruit, the widespread appeal of plastic is unique.

14 years earlier, Karl Ziegler drastically changed the arena of polymer synthesis when in 1953 his research team discovered that organometallic compounds could be used as catalysts to control the positioning of atoms attached to polymer chains. The catalysts allowed ethylene to be polymerized under standard conditions and in a straight chain, thereby avoiding the previously costly synthesis under high temperature and pressure that resulted in randomly branched chains. Shortly thereafter, Giulio Natta used Ziegler catalysts to control the polymerization of propylene and found that tacticity could be varied according to the organometallic catalysts used. The Ziegler-Natta catalysts permitted an efficient, cost-effective, and controllable route to polymerization not previously known and opened the door wide open for chemists of the 20th and 21st centuries to further advance the field of material science.

Macromolecules now serve an endless variety of purposes: they can be used as artificial limbs, organs, or tissues; they are used to transport and/or store electricity as well as digital output; they exhibit tensile strengths surpassing that found in steel and can be used in bridges and other architecture designs; they can change color with temperature or conductivity; they help reduce the spread of sexually transmitted diseases in the form of contraception; they serve to precisely deliver time controlled drugs to needful patients; they even mimic natural systems previously only possible under the guidance of the unmatched and most experienced chemist, Mother Nature. More impressively, scientists have recently shown that an understanding of materials at the molecular level can lead to predictable and desirable properties on the macroscopic scale.

The following three sections are dedicated to developing a fundamental understanding of the way in which materials are put together with an eye towards potential applications in the area of surface functionalization and crown ether based pseudo- and poly(pseudo)- rotaxanes. First, the functionalization of various material surfaces with monodisperse macromolecules will be discussed followed by a dialogue of self-assembly in supramolecular chemistry. Although the tone of the following chapters will switch by necessity to a more data based discussion of the science incorporated, I hope not to stray too far from the underlying message: continual research at the molecular level will help define the technologies, and ultimately comforts, of tomorrow.