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NYU Polytechnic Institute Internship 2013

Great Neck Breast Cancer Coalition: Summer Laboratory Research Internship

Upon my return to the NYU Polytechnic Institute this summer, I could not help but notice a growing sense of nostalgia. A whole year had already passed since I had last conducted my research there, and yet I could hardly believe it. All that time had just flown by, and I soon found myself in the familiar streets of Brooklyn once again as I walked into the school through the big glass doors. I recognized the security guards and I recognized the hallways and even some of the classrooms. Some things never change. I made my way to the elevators, which eventually took me up to the sixth floor, where the majority of my work would be done. Instead of feeling uneasy and anxious like I did last summer, I felt completely at home.

It did not take long to find Professor Gross, my research mentor, and he soon got me reacquainted with his team of PhD students, many of which I would be working with over the summer. I was glad to see many familiar faces, while also intrigued at the presence of some new ones. Throughout the summer, I was given the unique opportunity to work closely with them on their ongoing research, contributing my effort to their cause: bio-based polymers.

With the rapid depletion of petroleum and a general increase in consumer demand, interest in bio-based polymers has continued to grow in popularity. These bio-based polymers, unlike traditional petroleum-based polymers, are not derived from petroleum and are therefore sustainable and often bio-degradable. However, the existing concerns with bio-based polymers generally involve their weak mechanical properties, such as low tensile strength and impact resistance, as well as high gas permeability. Furthermore, bio-based polymers tend to have poor

thermal properties. In order to address these issues, we realized that these bio-based polymers had to be reinforced to become viable replacements to petroleum-based polymers.

Last summer we worked very heavily with cellulose, an abundant biopolymer, which has long been known for its potential as a reinforcing agent. Building on this previous research, we experimented extensively with cellulose, hoping to use it as a reinforcing agent for other bio-based polymers. However, we were presented with a handful of obstacles that needed to be overcome prior to using it for reinforcement. In order to promote fine polymer dispersion and improve stress transfer, the cellulose had to be broken down into smaller particles through acid hydrolysis, producing cellulose nano-crystals. In addition to this, we also had to modify the chemical properties of the cellulose, which is naturally hydrophilic. We employed Fischer esterification to modify the cellulose, producing hydrophobic properties similar to those of the polymers we hoped to reinforce. By doing so, the cellulose and the polymer would adhere well and demonstrate improved compatibility. We accomplished these tasks with a one step process, utilizing organic acids to react with the cellulose through acid hydrolysis and Fischer esterification simultaneously. This organic acid process further contributed to our green chemistry approach to polymer reinforcement, yielding significant results with minimal environmental drawbacks. By accomplishing this cellulose break-down and modification, we have effectively produced cellulose nano-crystals ready for introduction into a wide array of bio-based polymers.

Since oil is limited in quantity, its scarcity will undoubtedly have an enormous impact on consumers and producers. Consequently, replacing petroleum-based polymers is a crucial endeavor for the sake of future generations. In terms of current products, most commercial plastics are derived from petroleum. Since this form of material creation must eventually come to

an end, the search for viable bio-based plastics is paramount. But aside from the diminishing petroleum aspect, it is also important to recognize the potential health hazards of current plastics. Many have accused these plastics of contributing to the onset of cancer, while others point at the chemicals within the plastics that are used during the creation process (plasticizers). Regardless of what is at fault, the bio-based plastics that we have been working to create could eliminate the need for traditional plastics, thus ending the controversial debate over their carcinogenic properties. Instead, the bio-based plastics that we would use as a replacement would be completely green in terms of sustainability and biodegradability. They would have minimal environmental drawbacks and no plasticizer additives.

As of now, we have been particularly interested in two bio-based polymers that could eventually replace their petroleum-based counterparts. These two polymers, PLA (Polylactic acid) and PBSA (Polybutylene Succinate-co-Adipate), demonstrate remarkable potential to displace traditional plastics used in cups, food packaging, toys, and even grocery bags. The possibilities are endless, and there is still significant work that must be done before we can move towards a world of bio-based plastics. Nonetheless, the work that we have done throughout our summer research has been a vital step towards mitigating the impact of traditional plastics. I am glad to say that it was an unparalleled experience that I was privileged enough to participate in. These last two summers have been arguably the most influential and developmental experiences in my life. I will always consider myself fortunate for the tremendous opportunity that the Great Neck Breast Cancer Coalition has extended to me through this student research program.