Sum(mer) Kind of Wonderful [1]

Submitted by Mathini Vaikunthan [2] on 5 August 2016 - 11:58am

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My mentor, another graduate student I worked closely with and myself at Playa Jungla

This ten week REU program has been many kinds of wonderful. From the wonderfully kind people, to the wondrous food, to the many wonders we encountered on the island, I could not have asked for a better way to spend my summer. Just as exciting as the fact that I was in Puerto Rico was the fact that I was working on something completely new to me: materials research in the Mechanical Engineering Department. I am a Chemical and Biological Engineer, so when I found out that I was investigating the viscoelastic properties of composites highly loaded with carbon nanotubes, I was slightly fearful because I only understood at most two words in that project description.

With the help of my mentor and my professor, however, I had no problem engrossing myself in the work being done in this lab, because it was extremely interesting. Carbon nanotubes are like rolled sheets of graphene; they are super strong allotropes of carbon that have gathered a growing interest. Their properties, like an Elastic Modulus of 1 TPa (higher than almost all other industrial fibers including Kevlar, steel, and diamond), and a compressive strength of 150 GPa make it a true wonder material that could revolutionize many industries. The problem is, there is no easy way to harness all of this strength; when woven into yarn or sheets, the CNTs tend to agglomerate due to weak electrostatic forces. This results in disorganized structures where the CNTs can slide past each other when a stress is applied, making the overall structure weaker. The remarkable properties for CNTs are limited to when they are secluded from other CNTs, so a common application of CNTs is in composites. If a composite can be made with some sort of matrix, using CNTs as a filler and the fibers of the matrix to break up agglomerations, then a lightweight composite with enhanced mechanical properties can be constructed.

Our work was to try to make a composite with a high concentration of CNTs. Most composite formation methods include a very low concentration of CNTs because they involve mixing the composite solution in liquid form and the addition of CNTs dramatically increases the viscosity making mixing difficult. To avoid this, we used a sandwich approach, with layers of CNT sandwiched in between layers of a thermoplastic called PEEK. The “sandwich” was put into something resembling a panini press, where an annealing process would take place to allow the strands comprising the matrix to infiltrate the agglomerations of CNTs.

We wanted to see if higher concentrations of CNT would lead to better mechanical properties, and if the fact that the CNT was single walled or multi walled made any difference. We expected the SWCNT to form stronger composites because MWCNTs are weaker than SWCNTs due to the sliding of the CNTs that comprise the multiple walls.

By using viscoelastic properties and dynamic testing, we were able to see that it seemed like MWCNTs actually exhibited better properties in our composites. This could be because they absorb more heat, which allows the plastic to diffuse around them more evenly.

The project could be frustrating at times, many of our samples failed to be effective just due to limitations on machinery, but this only fueled the project forward because we learned what had to be improved upon for the future. My professor told me that I would not forget the principles of viscoelastic materials, and he was right. I will also never forget my ten weeks here, I won’t forget the mountains or the beaches or the waterfalls; I won’t forget the coquis or the mofongo or the salsa dancing; and most of all, I won’t forget the people who made this experience what it was. I could not start to mention all of them in my acknowledgements section of my poster, and I could

not hope to mention them all here, but they treated me like family, and I will forever be grateful because they were some kind of wonderful.

Tags:

- REU RMSM [3]

Links
[1] https://www.cienciapr.org/en/blogs/soft-matter/summer-kind-wonderful?language=es [2] https://www.cienciapr.org/en/user/mathini-vaikunthan?language=es [3] https://www.cienciapr.org/en/tags/reu-rmsm?language=es