MECHANICAL REDUCTION OF RECYCLED POLYMERS FOR EXTRUSION AND REUSE ON A CAMPUS LEVEL

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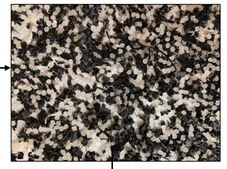
ABSTRACT

Environmental plastic pollution has exponentially increased over the last few years, resulting in 6.3 out of the 8.3 metric tons of plastic produced each year worldwide, ending up in landfills or natural environments. Much of the plastic waste is a result of wrongful disposal or improper recycling category placement. Improperly recycled plastics can occur anywhere from the household, where it is stated that only 9% of plastic is correctly recycled, to universities [1]. Besides more education on proper recycling practices, higher education systems need to investigate potential areas of instruction that would allow for plastic reuse. One area includes courses dealing with 3D printing; 3D printing filament's yearly consumption is estimated at around 30 million pounds worldwide. [2] To reduce this amount, classes using 3D printing in their curriculum should consider shredding, re-extruding, and re-using the scraps created from flawed prints – using effective recycling. Recycling is not a standard practice used as some worry the recycled filament will create inadequate prints. To demonstrate the value of using recycled polymers standard mechanical tests were done to establish that important qualities are maintained after recycling. Through multiple tensile tests run on 3D printed samples using a Universal Testing Machine (UTM) with both virgin polylactic acid or polylactide (PLA), and recycled PLA, polyethylene terephthalate (PET), and polyethylene terephthalate with glycol added (PETG) plastics, it was discovered that the ultimate tensile strength (UTS) for virgin PLA was 6343.45 psi in comparison to recycled PLA that exhibited a value of 4686.80 psi. This result showed only a 23.25% decrease in its strength. 100% PET exhibited a UTS of 4481.27 psi with a 29.36% decrease compared to the UTS of virgin PET UTS. These experiments demonstrated that the recycled filament materials show a high enough UTS to create usable and adequate prints. These results verify that 3D prints using recycled plastic found on campuses (such as scraps from 3D printing labs and PET water bottles) can be used to reduce the volume of plastic waste that universities contribute to landfills.

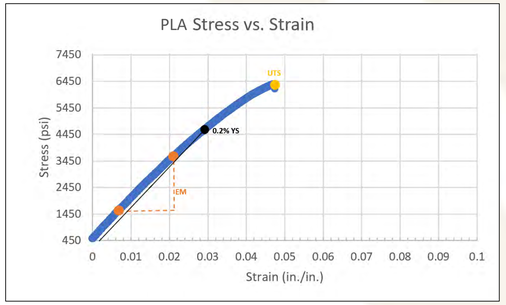
INTRODUCTION

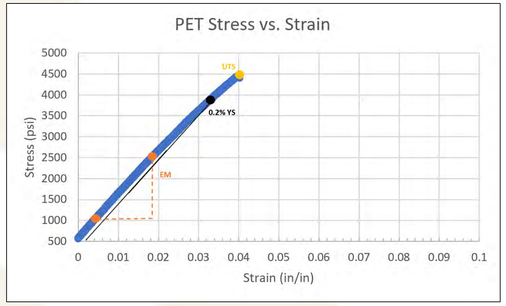
By the year 2050 there will be around 12 billion tons of plastic in landfills. Today, many materials are now in the process of being 3D printed including metals, ceramics, paper and as stated above, plastic. As amazing as this technology is, an article written back in 2015 stated that the yearly consumption of 3D printing filament is estimated around 30 million pounds.

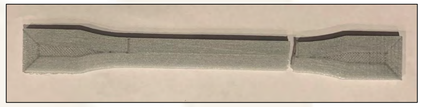
EXPERIMENTAL



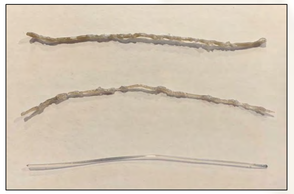
ANALYSIS & DISCUSSION







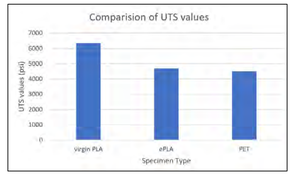
- **the PET material exhibited a UTS value that was 70.64% of the UTS strength shown in the virgin PLA specimen. The addition of glycols in the PETG specimen helped create a more consistent filament but resulted in a more fragile and less adhesive material. Along with the recycled PLA, 100% PET seems to be a suitable replacement for virgin PLA in 3D printing classes on a university campus.**

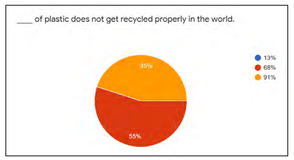


- **The PET was notably chunky with nonmelted pieces of PET incorporated throughout the filament. By gradually increasing the temperature and giving the extruder some time, a smoother and consistent filament followed. (Starting at 235°C – 275°C)**

- **Adhesion is an important part of 3D printing and can affect not only how the part looks but also how strong the part is. The cone showed layer separation, and poor adhesion. By increasing the printing temperature in all the layers (except for the first so that the print does not overly stick to the bed) from 260°C to 270°C The new print came out as a solid product**

CONCLUSION





- **The PET specimen retained 70.64% of the mechanical behaviors shown in the PLA filament tested.**
- **The UTS of the recycled PLA mixed specimen maintained 73.84% of the UTS properties found in the virgin PLA specimen**
- **The PETG specimen sustained 73.68% of the UTS strength of the virgin PLA specimen (not shown in the above graph comparison). However, because of the materials' lack of adhesion, the PETG elastic modulus had a value 50.22% lower than the virgin PLA.**
- **The graph above shows a lack of knowledge among the student population where 55% of the students believe that only 68% of plastic gets recycled incorrectly, when the real value is 91%. [1] The survey is an excellent example of the lack of information circulating throughout communities and campuses about the created waste.**

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