# Analyzing the Effect of Grade on HDPE Polymer Composites for 'Plarn' Bag Applications

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## INTRODUCTION


Figure 1. Plarn tote bag vs. Cotton tote bag. *Courtesy of aNYbag and Walmart.*

Figure 2. Photo of homemade plarn skeins. *Courtesy of Needlepointers.com*

- 'Plarn' is what crafters call yarn created with cut plastic bag film
- Used to re-purpose plastic bags into other products
- Low process—requiring less money, energy, and resources
- Lack of research—little known about plarn's viability as a recycled plastic material
- Most common application of plarn is weaving or crocheting the strands into bags
- In this study, we are evaluating how the relevant mechanical properties of plarn change as a function of material and grade

## METHODS

**Below are the main steps used in analyzing key properties and environmental impact of select plarn materials, using material design software (CES EduPack):**

1. **Identify materials via literature review:** Choosing plastic types that are most commonly used to make plarn.
2. **Perform property modeling:** Results will facilitate selection of desired properties and price of select plarn candidates.
3. **Analyze effect of material and grade:** Systematically, we evaluate how these parameters affect properties and performance of potential plarn bags.

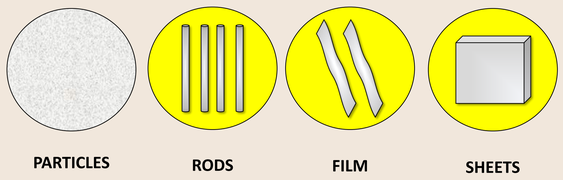


**Figure 3.** The possible 'grades' of a material.

## RESULTS

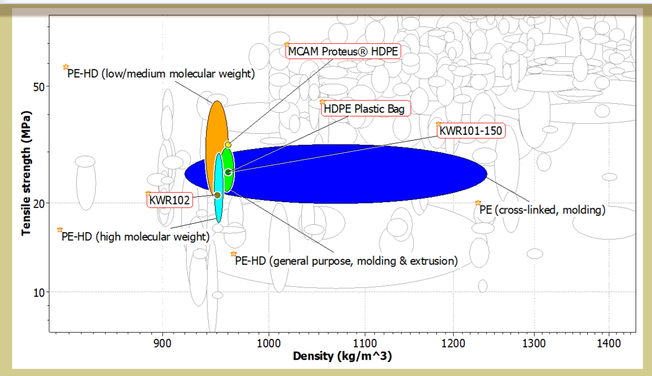


**Figure 4.** An overview of the materials we've been researching.

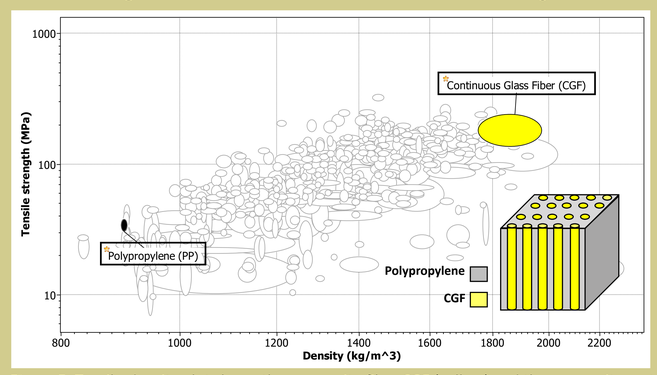


**Figure 5.** Tensile-density plot shows the composite fiber CGF (yellow) and the composite matrix PP (black).

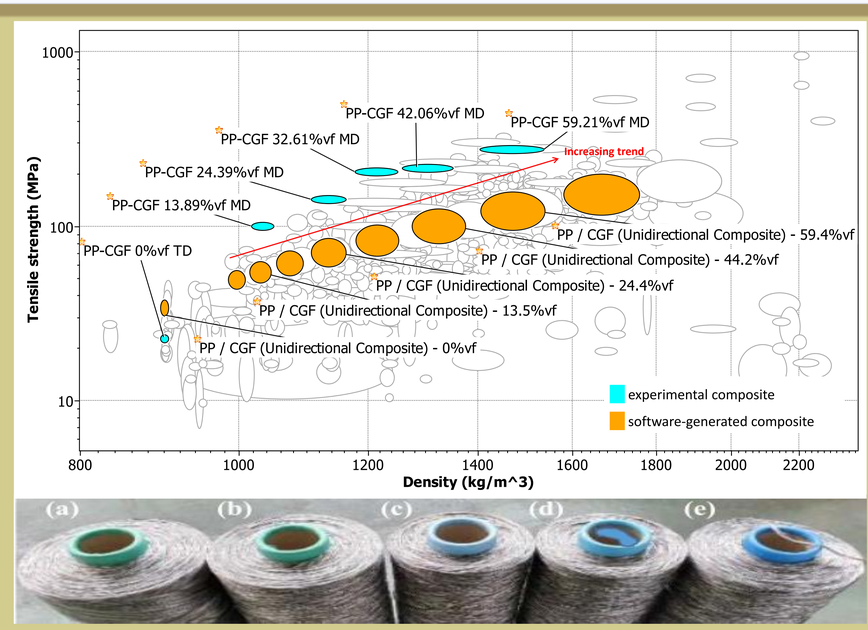





**Figure 6.** Verification plot of the unidirectional fiber composite model using CES EduPack. Prediction results from CES are shown in orange vs. experimentally reported elsewhere in blue. [8]
Experimental composite material pictured as reported independently. [8]

$$\tilde{\rho} = f\rho_r + (1-f)\rho_m$$

**Equation 1.** Relation for overall density of the composite. One of the equations used for model verification. [9]

## DISCUSSION AND FUTURE WORK

### DISCUSSION

- **Figure 4:** The original polymers offer a range of possibilities given their different properties.
- **Figure 5:** Our case study proved that a light, relatively weak plastic can become more robust when combining it with a stronger, denser fiber. Many fiber types may be used to explore other new composites.
- **Figure 6:** The experimental composite data we gleaned from our reference paper followed a similar trend to the composite data. Although the trend is not perfect the model is useful for predictions.

### FUTURE WORK

- This study can potentially make it easier for researchers, or businesses determine the technical and commercial feasibility of new plarn materials tailored for bags and other applications.
- Once satisfactory compositions and grade (film, strands, etc.) are established, efforts will need to include experiments and economic analysis for feasibility of large-scale sustained manufacturing with little ecological impact to the environment.
- The overall goal of this research is to help decrease plastic pollution in the environment as the plarn technique is progressively adopted in both commercial and personal endeavors.

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