



# Role of Interfacial Crystallization on Multilayer Polyolefin Films



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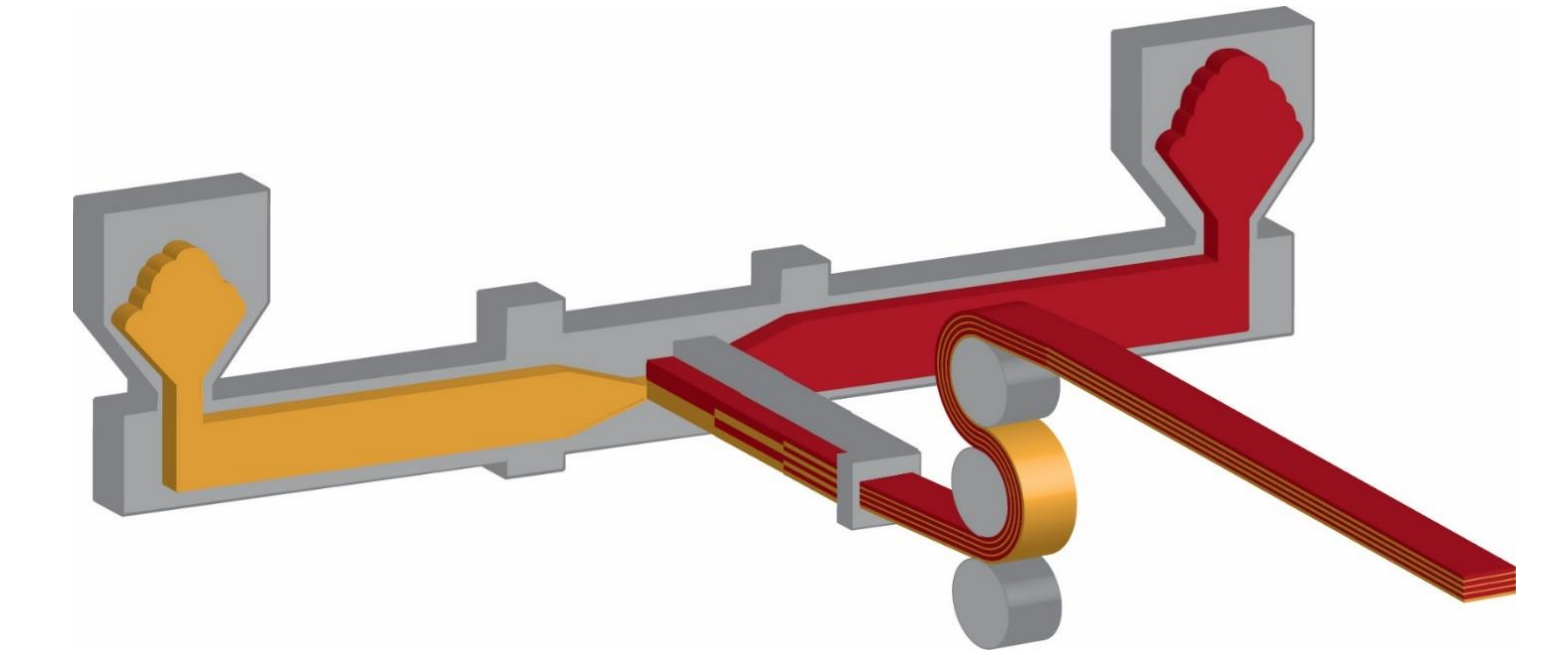
## Introduction:

- Global production of polyolefins is on the rise; growing from 130.5 million tons in 2014 and is expected to reach 170 million tons in 2017, an annual compound growth rate of 4.5%. Polypropylene (PP) and polyethylene (PE) dominate the growing worldwide polyolefin market, <sup>2</sup>with PE capturing a 35% market share in the US. <sup>1</sup>
- Although PP and PE are chemically similar polymers its widely known that they are immiscible and adhere poorly to one another. <sup>3</sup> Traditionally Ziegler-Natta catalysts have been used for industrial PP and PE synthesis; a main feature of Zeigler-Natta type catalyst is a large dispersity index with a significant fraction of low molecular weight chains that are unable to crystallize. <sup>4</sup>
- By using a metallocene catalyst in place of a Ziegler-Natta type catalyst the fraction of lower molecular weight chains is reduced.

## Goals:

- Relate interface adhesion to specific mechanical properties.
- Use the process of coextrusion to fabricate three different 80 layered films
- Characterize and test the mechanical properties of 80 layer films with different catalyzed PE and PP

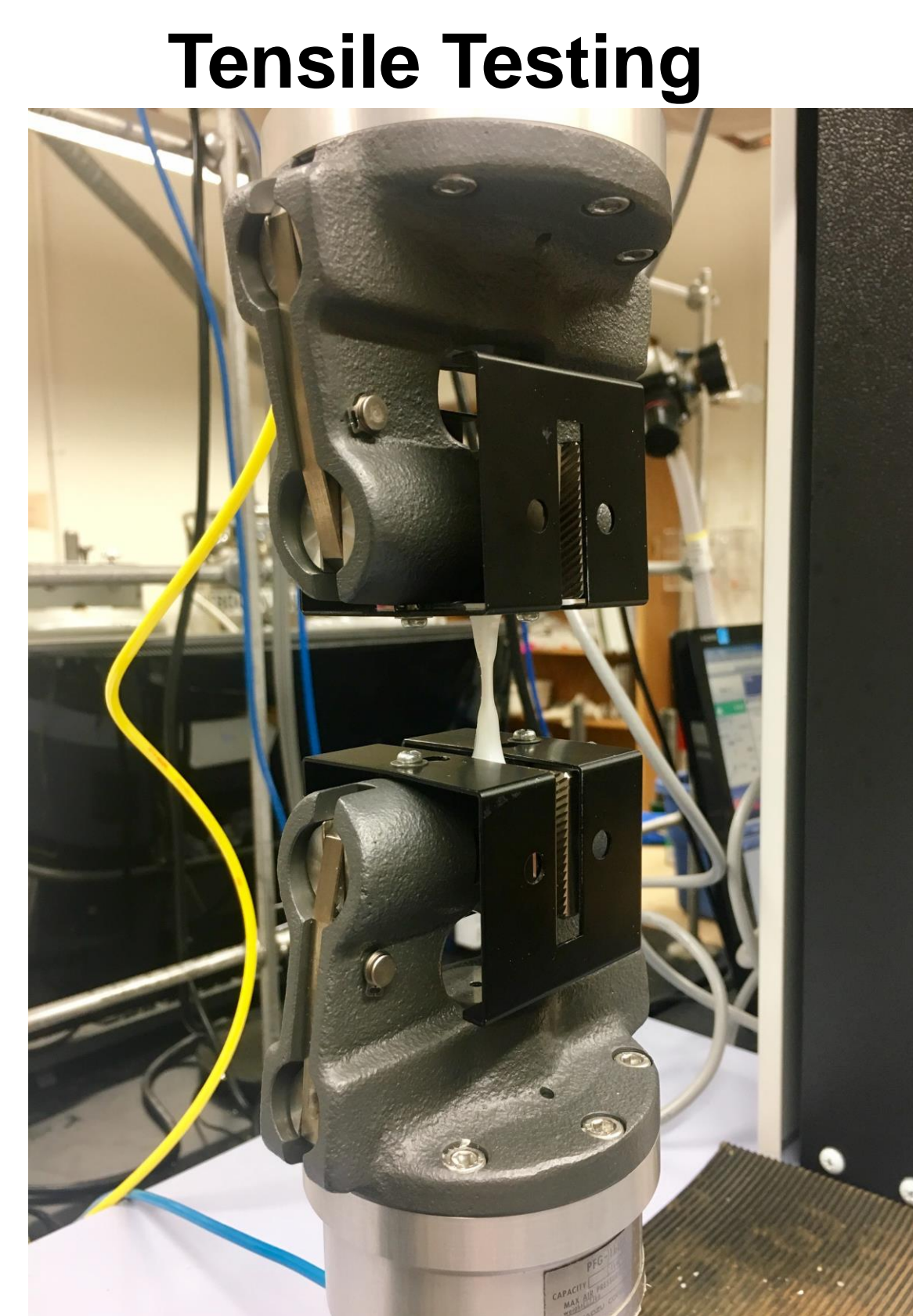
## Film Fabrication and Coextrusion:



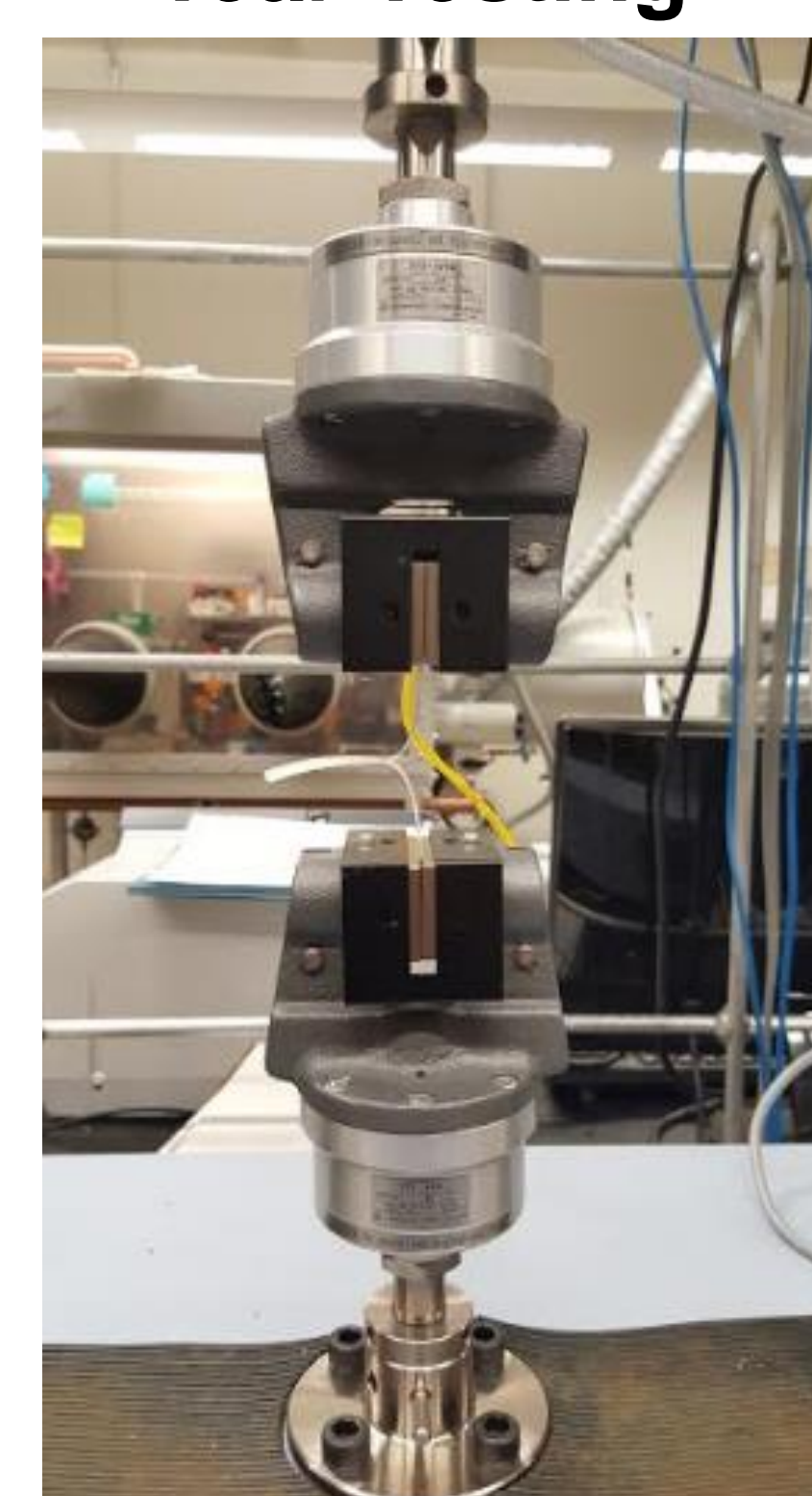
- Two different polymers loaded on each side
- Gear pumps control the volume compositions
- Die controls the initial number of layers
- Multipliers double the number of layers

## Testing:

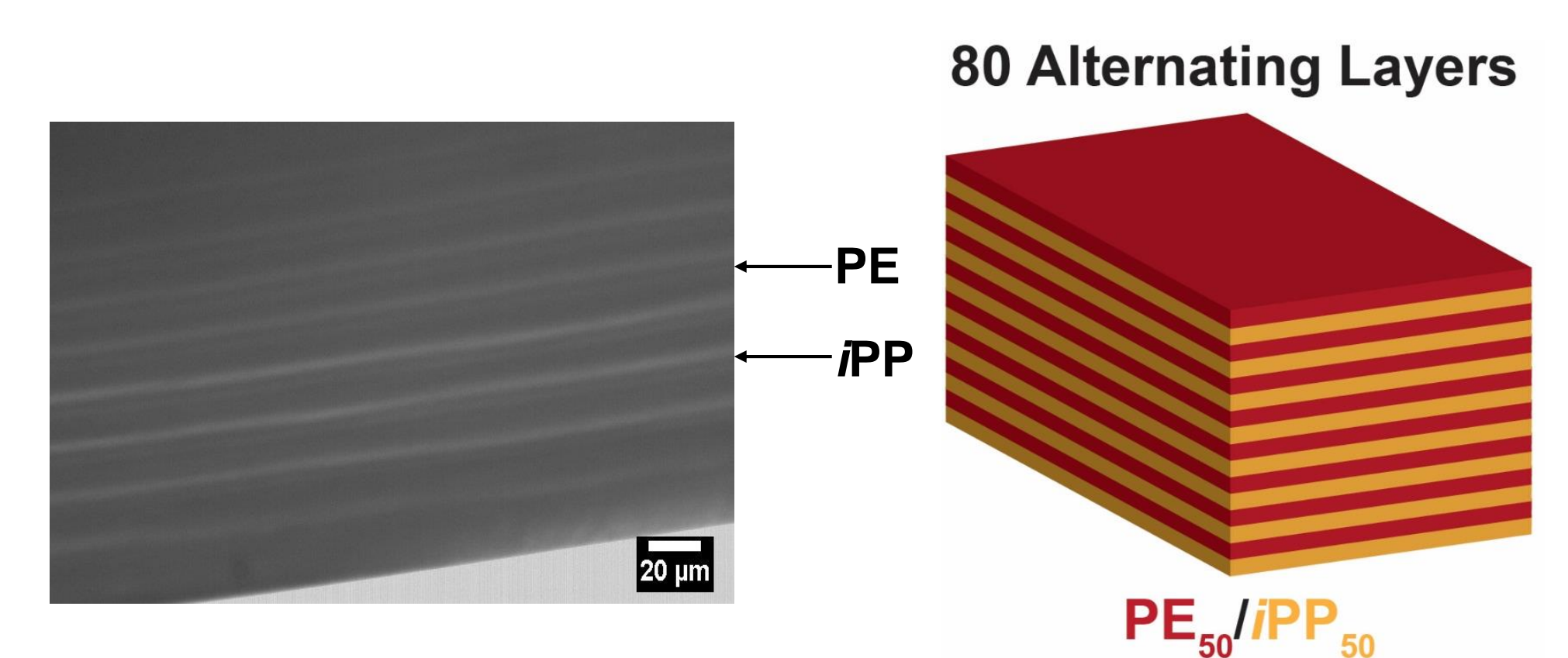
Two tests were conducted on the multilayered films.



Tensile Testing

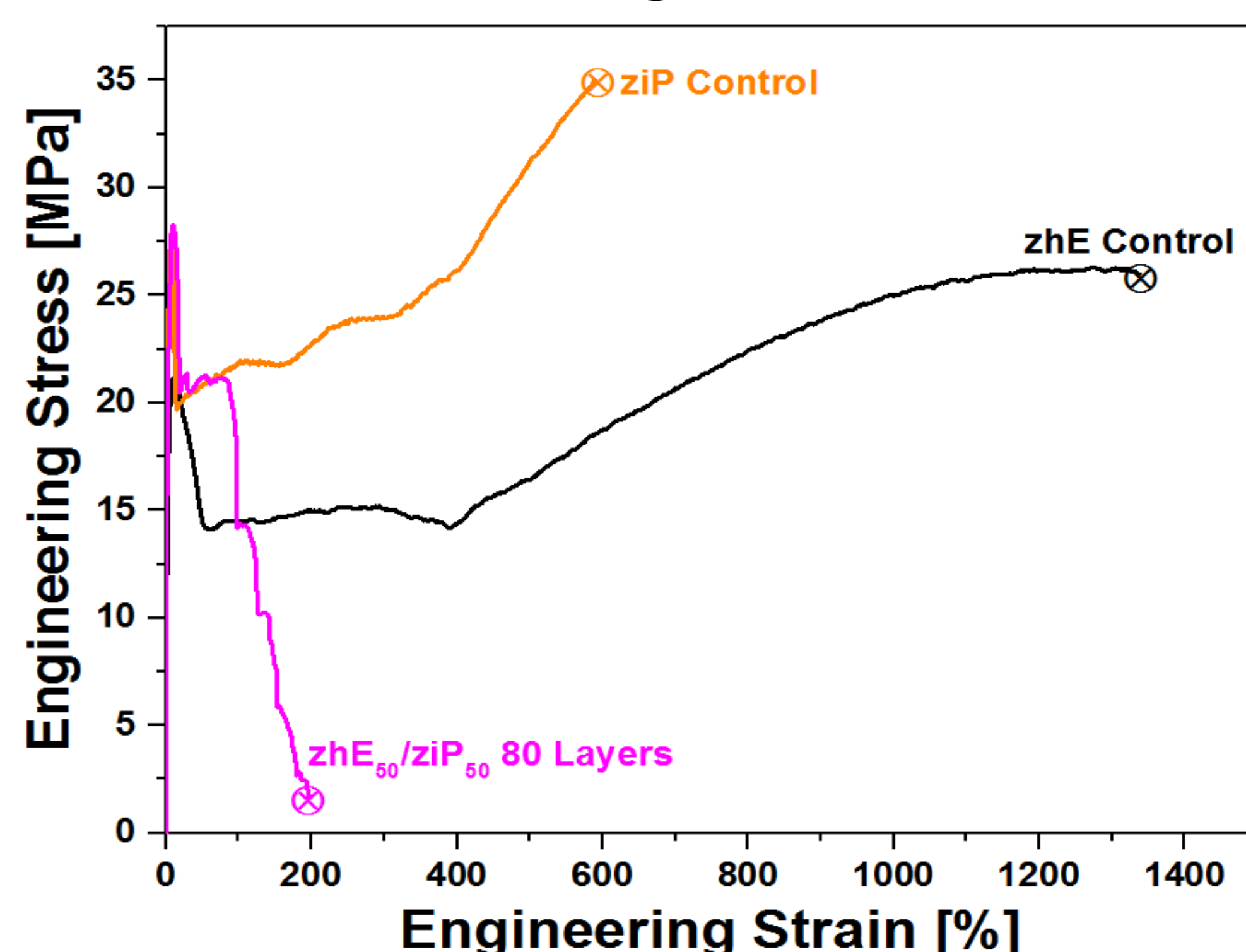


Tear Testing

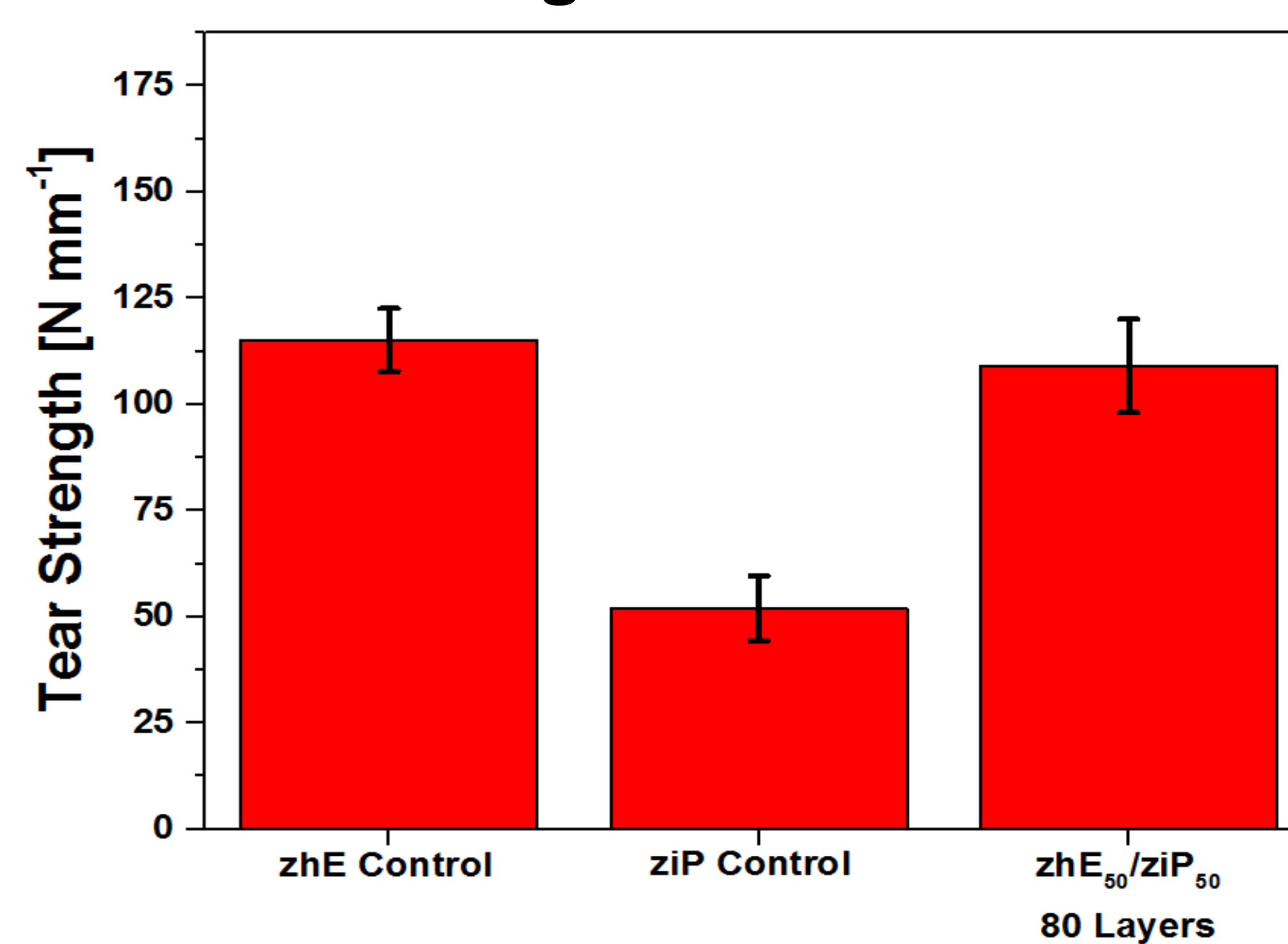


## Results:

### Tensile Testing:



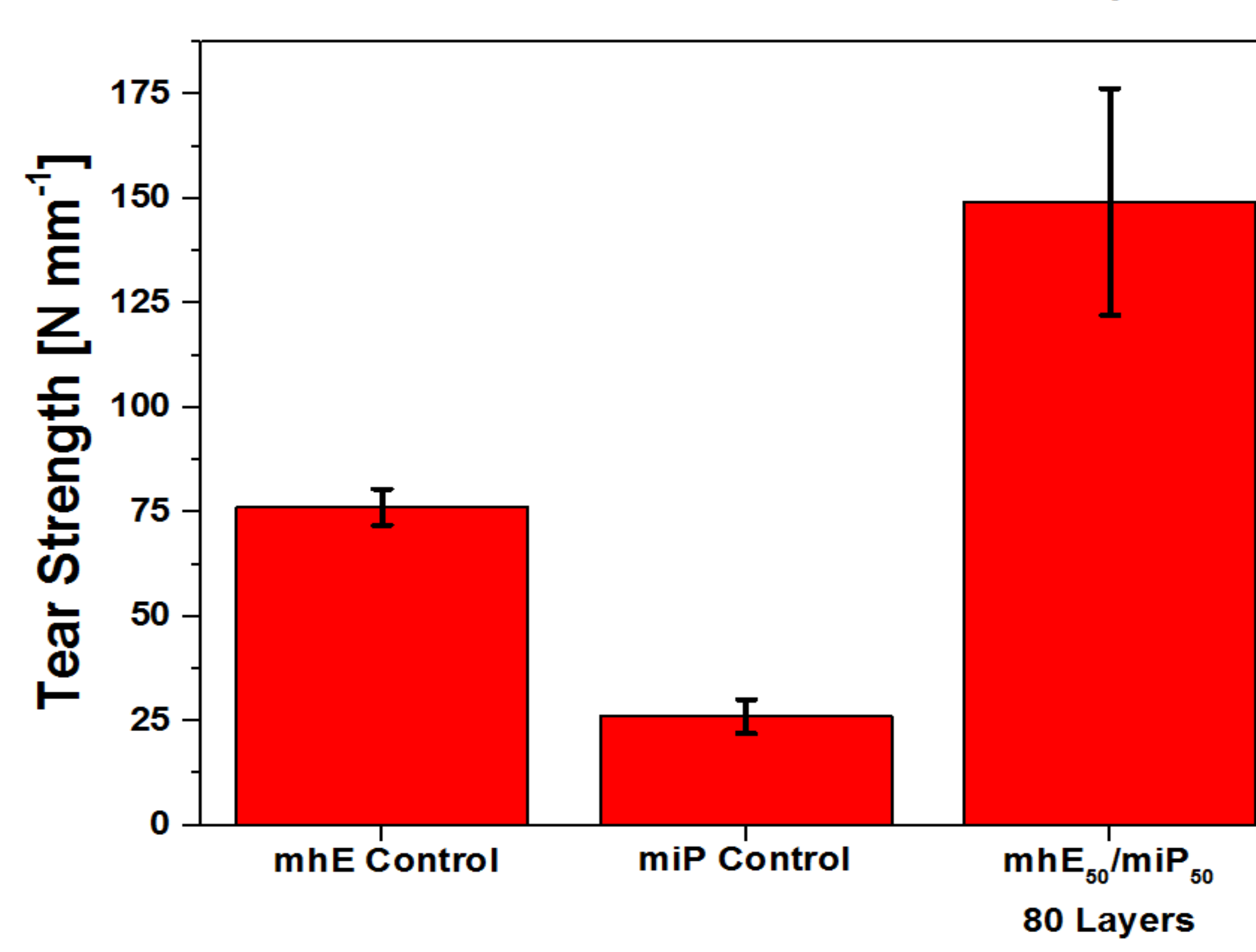
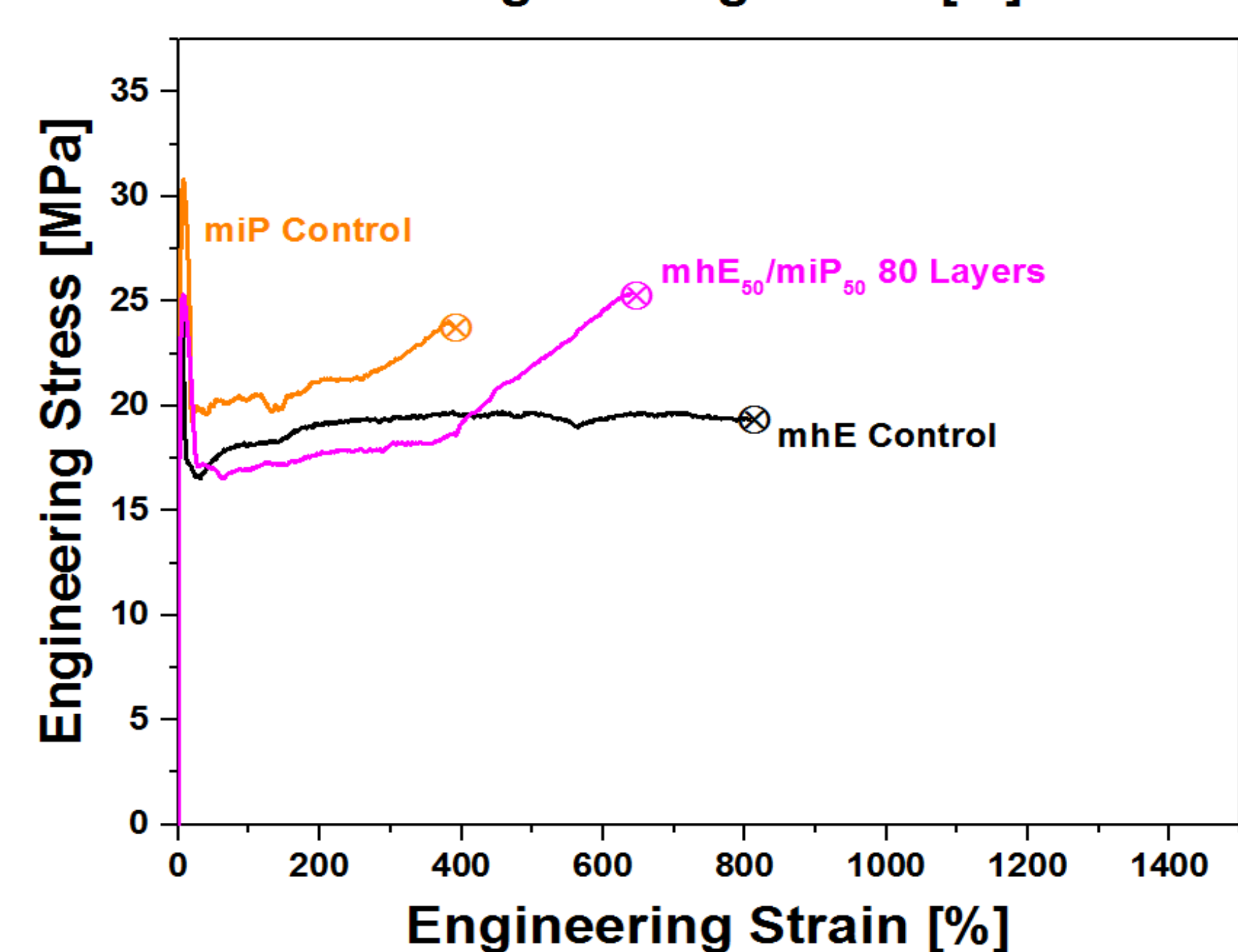
### Tear Testing:



## Materials and Nomenclature:

xyz

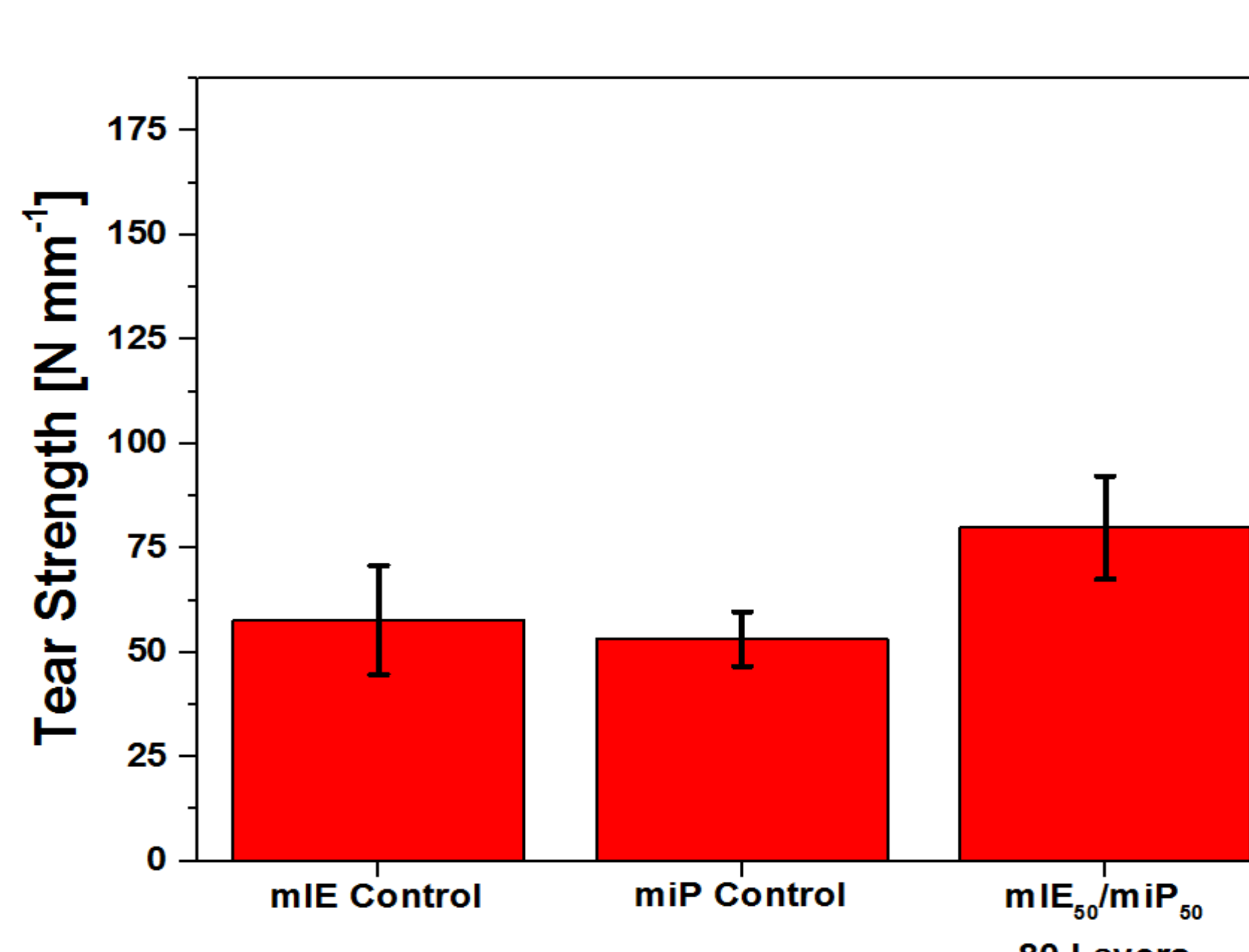
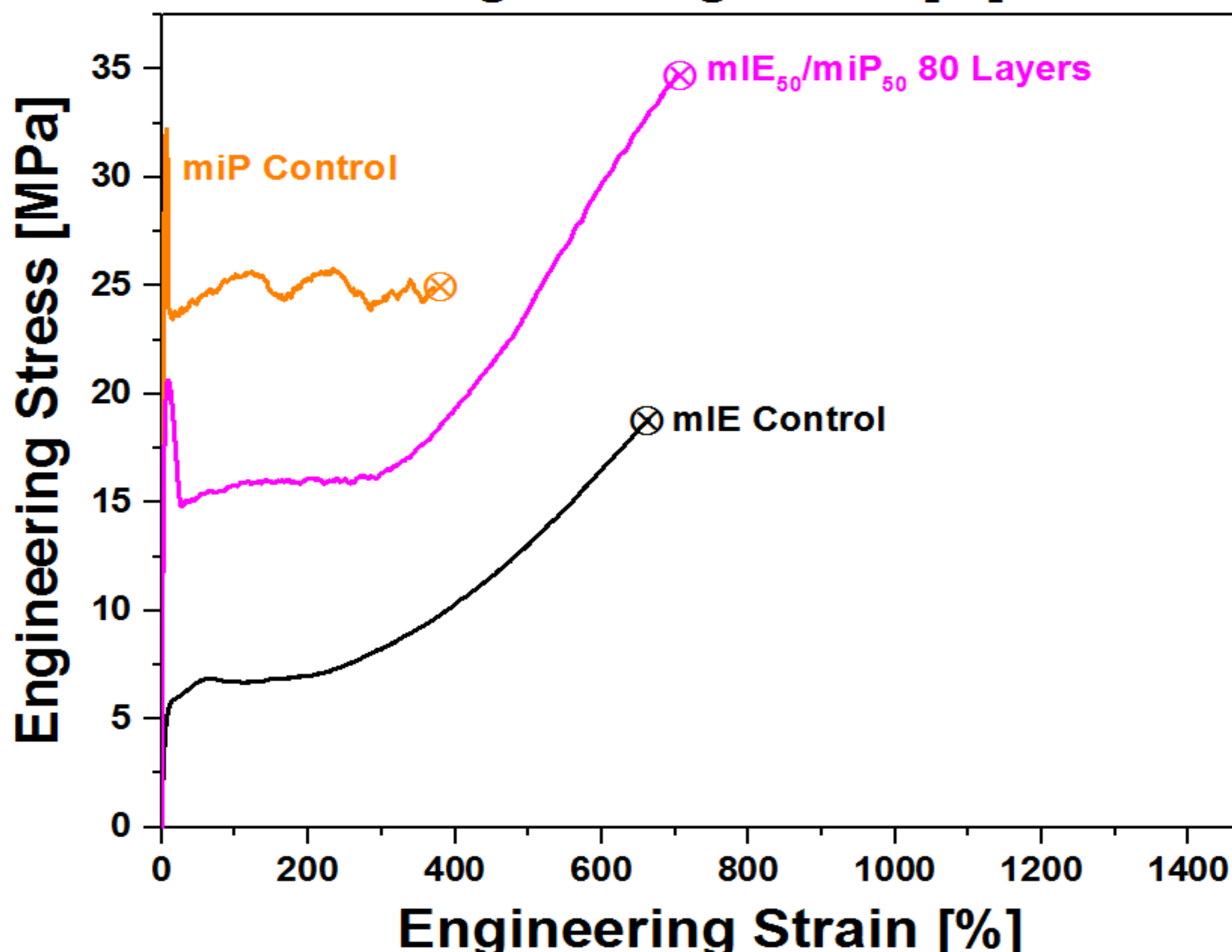
- x → Catalyst: m = metallocene; z = Ziegler-Natta
- y → Architecture: i = isotactic; h = high density; l = linear low density
- Z → Polymer: E = polyethylene; P = polypropylene



## Conclusions:

### Tensile and Tear Testing:

- The Zeigler-Natta catalyzed HDPE/iPP 80 layered film showed less toughness and elongation in comparison to the Zeigler-Natta catalyzed iPP and HDPE controls
- The metallocene catalyzed HDPE/iPP and LLDPE/iPP 80 layered films showed a higher toughness than the metallocene iPP control and a greater elongation than the metallocene catalyzed HDPE
- The tear test showed that the two metallocene multilayered films had a higher tear strength than the controls
- The Zeigler-Natta catalyzed multilayered film did not show an improvement of tear strength in respect to the two controls
- This shows a direct relationship between Chaffin et al. work on adhesion and mechanical properties of the 80 layer films<sup>4</sup>
- The stronger the adhesion the stronger the tensile and tear strength
- This is due to the individual layers being “glued together” creating on large strand as opposed to several small strands that require much less to break apart.



## References:

- Wood, L., Global Polyolefins (PO) Market Drivers, Business Wire, 2016
- Ceresana, Market Study: Polypropylene. 3rd Edition ed.; 2014.
- D. Witter, IBIS World Industry Report 32521: Plastic & Resin Manufacturing in the US; Industry Report; IBIS World Inc., 2015.
- Chaffin, K.A.; Bates F.S.; Brant, P.; Brown, G., *Journal of Polymer Science*, 1999, 38, 108-221

## Acknowledgement:

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